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Contents

EINE NEUE SYNTHESE VON ALIZARIN.
(Kondensation von Phtalsäureanhydrid mit o-Chlorphenol)

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(Eingegangen am 23. Jan. 1927.)

Das Alizanin (1.2-Dioxy-9. 10-anthrachinon) wurde im Jahre 1826 von Colin und Robiquet aus der Krappwurzel[1] isoliert. Es findet sich im Krapp in Gestalt eines Glykosids, der sogenannten Ruberythrinsaure, welche von Rochleder zuerst in reinem Zustand dargestellt wurde. Nach Graebe und Liebermann kommt der Ruberythrinsaure die Formel $C_{26}H_{28}O_{14}$ zu. Durch Erhitzen mit verdünnter Salzsaure zerfallt sie in Alizarin und Glykose.

$$C_{26}H_{28}O_{14} + 2H_2O \longrightarrow C_{14}H_8O_4 + 2C_6H_{12}O_6$$

Synthetisch[2] lasst sich das Alizarin neben dem isomeren Hystazarin durch Erhitzen von Brenzkatechin mit Phtalsaureanhydrid und Sohwefelsaure darstellen.

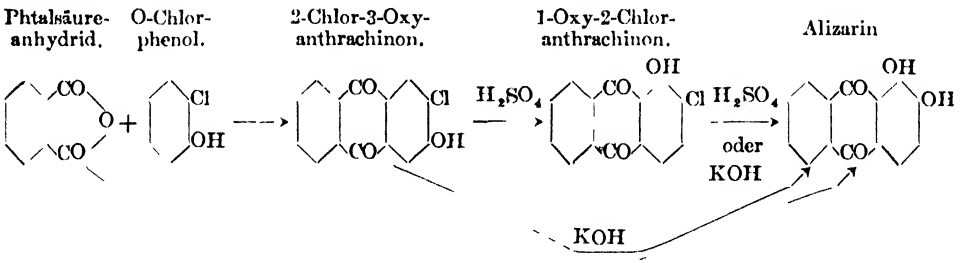
Es wurde nun beobachtet, dass sich bei der Kondensation von Phtalsaureanhydrid mit o-Chlorphenol in Schwefelsaure, drei verschiedene Körper bilden:

I 2-Chlor-3-oxy-9.10-anthrachinon.
II 2-Chlor-1-oxy-9.10-anthrachinon.
III 1.2-Dioxy-9.10-anthrachinin = Alizarin.

Diese neue Synthese ist nicht nur vom theoretischen Standpunkt aus interessant, sondern auch sehr wichtig für technische Zwecke. Erhitzt man o-Chlorphenol und Phthalsaureanhydrid mit Borsaure[3] und Schwefelsaure auf 195°, so findet man das bekante 2-Chlor-3-Oxyanthrachinon, steigert man jedoch die Temperatur bis auf 225°, so wird die 3-standige Hydroxylgruppe nach der 1-Stelle umgewandelt und man bekommt das unbekannte 2-Chlor-1-oxyanthrachinon. Steigert man schliesslich die Temperatur bis auf 255°, so wird das Halogenatom vollkommen in Hydroxylgruppe[4]

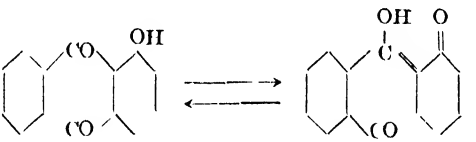
(1) Perkin and Everset : Natural Organic Colouring Matters.
(2) Liebermann : Ber **21**, 2501 (1888)
Liebermann u. Schöller : Ber. **21**, 2503 (1888)
Liebermann u. Hohenemser : Ber. **35**, 1780 (1902)
Vgl. auch : Paeyer u. Caro. Ber. **7**, 972 (1874)
(3) Vergl. Ullmann : D. R. P. 282,492 u. D. R. P. 255,031
(4) Ullmann n. Conzetti : Ber. **53**, 833 (1920), By. D. R. P. 203,083.

übergeführt und eine unbetrachtliche Menge Alizarin (75 % der Theorie) gebildet.



Es hat sich ausserdem gezeigt, dass bei der Kalischmelze des 2-Chlor-3-oxyanthrachinons die 3-standige Hydroxylgruppe zuerst nach der 1-Stelle wandert und dann das 2-standige Halogenatom in die Hydroxylgruppe umgesetzt wird. Behandelt man 1-Oxy-2-chlor-anthrachinon mit Kali, so wird natürlich das 2-standige Halogenatom sofort in die Hydroxylgruppe umgesetzt. Aber in beiden Fallen bildet sich sehr wenig Alizarin, da das α-standige Halogenotam nicht so leicht in die Hydroxylgruppe umgesetzt wird wie das β-standige Halogenatom.[5]

Sehr bemerkenswert ist bei dieser Umwandlung oder Umlagerung der Hydroxylgruppe dass dieselbe in der α Stelle die Verwandschaft mit der Carboxylgruppe hat. Man kann vermuten, dass α-Oxy-anthrachinon die tautomere o-Chinoid Form besitzt.



Dies stimmt mit zwei Erfahrungen überein. Nach der von Graebe bei der Methylierung der Oxyanthrachinon gemachten Erfahrung wird die α-standige Hydroxylgruppe weder durch Jodmethyl noch durch Methylsulfat entweder nicht oder nur sehr unvollkommen methyliert; Dimroth[6] gibt an, dass in Anthrachinonderivaten die α-standigen Hydroxylgruppen sehr viel trager acetyliert werden als die β-standigen.

Experimenteller Teil.

2-Oxy-3-chlor-9. 10-anthrachinon.[7]

(5) Decker u. Laube : Ber. **39**, 133 (1900)
(6) Dimroth : Ber, **53**, 481 (1920)
(7) D. R. P. 148,110.

In 160g. Schwefelsauremonohydrat werden 30g. Phtalsaureanhydrid, 15g. Borsaure und 10g. o-Chlorphenol eingetragen. Man erhitzt 1 Stunde lang auf 195°. Die Aufarbeitung erfolgt durch Eingiessen der erkalteten Schmelze in Wasser, Abfiltrieren, Auskochen mit viel Wasser und Trocknen. Die aus Eisessig und Tierkohle umkrystallisierte Substantz bildet goldgelbe Nadeln, welche bei 258° schmelzen. Die Ausbeute betragt 3–4g.

507 mg. Sbst:	11 95 mg.	CO_2	1.25 mg.	H_2O
$C_{14}H_7O_3Cl$	Ber.	C 65 0 %		H 2.71 %
	Gef	C 64 4 %		H 2.75 %

3-Chlor-2-acetoxy-9. 10-anthrachinon.

Der Oxykörper wird in Essigsaureanhydrid zum Sieden erwarmt und 1–2 Tropfen konz. Schwefelsaure hinzugegeben. Aus Eisessig umkrystallisiert, zeigt das Acetylderivat den Schmelzpunkt 197°–200° und stellt schwach gelb gefarbte Nadeln dar.

7.12 mg. Sbst:	16.70 mg.	CO_2	2.02 mg.	H_2O
$C_{16}H_9O_4Cl$	Ber.	C 63.9 %		H 2.99 %
	Gef.	C 63.7 %		H 3.13 %

Umwandlung von 2-Oxy-3-chlor-9. 10-anthrachinon in Alizarin.

Man erhitzt 1g. 2-Oxy-3-chlor-9. 10-anthrachinon mit 20 g. Kali und etwas Wasser unter bestandigem Schütteln bis violette Farbung eintrit. Das Reaktionsprodukt ist anfangs rot, dann dunkelgrau und schliesslich violett. Nach dem Erkalten löst man die Schmelze in Wasser, Sauert mit Salzsaure an, filtriert und trocknet. Es wird sublimiert und aus Eisessig umkrystallisiert. Schmelzpunkt 289°

3 35 mg. Sbst:	8.55 mg.	CO_2	1 05 mg.	H_2O
$C_{14}H_8O_4$	Ber.	C 70.0 %		H 3.30 %
	Gef.	C 69.7 %		H 3.49 %

Das Diacetylderivat schmelzt bei 179°–183°.

1-Oxyl-2-chlor-9, 10 anthrachinon.

10g. o-Chlorphenol und 32g. Phtalsaureanhydrid wurden mit 20g. Borsaure und 160g. konz. Schwefelsaure auf 225° erhitzt bis die unter Gasentwickelung eintretende Reaktion nachlasst (ca. 2 Stunden). Die Schmelze wurde mit etwas Wasser zersetzt, zur Verseifung des Borsauresters einige Zeit gekocht und nach dem Verdünnen mit etwas Wasser der ausgeschiedene orange gefarbte 1-Oxy-2-chlorkörper filtrirt und neutral gewaschen. Das Rohprodukt ergab durch Umlösen aus Eisessig mit Tierkohle 7g. reine, bei 215° schmezende orange gefarbte Nadeln.

5.10 mg. Sbst.	12.25 mg.	CO_2	1.20 mg.	H_2O		
0.1015 g. Sbst:	0.0564 g.	AgCl				
$C_{14}H_7O_3Cl$	Ber.	C 65.0 %		H 2.71 %	Cl	13.73 %
	Gef.	C 65.6 %		H 2.61 %	Cl	13.65 %

Dieser neue Körper erwies sich leicht löslich in Alkohol, Äther, und Eisessig. Es löst sich in Alkalien mit roter Farbe. 1-Acetoxy-2-chlor-9. 10-anthrachinon stellt gelbe Nadeln (aus Eisessig) dar, Schmlzpunkt 176°-179°.

11.20 mg.	Sbst:	26.20 mg.	CO_2	2.80 mg.	H_2O
$C_{14}H_8O_4Cl$	Ber.	C 63.9 %		H 2.99 %	
	Gef.	C 63.8 %		H 2.78 %	

Umwandlung von 1-Oxy-2-chlor-9. 10-anthrachinon in Alizarin.

Der 1-Oxychlorkörper wird genau so behandelt wie oben sein Isomeres. Darauf entsteht Alizarin, Schmp. 289°.

5 55 mg.	Sbst:	14 15 mg.	CO_2	1 40 mg.	H_2O
$C_{14}H_8O_4$	Ber.	C 70.0 %		H 3.30 %	
	Gef.	C 69.8 %		H 2.81 %	

1. 2-Dioxy-9. 10-antoi achinon.

10g. o-Chlorphenol, 32g. Phtalsaureanhydrid, 20g. Borsaure und 160g. konz. Sohwefelsaure werden auf 240° erhitzt, worauf starke Gasentwicklung beginnt. Nach 1 Stunde treibt man die Temperatur auf 255°, wobei man das Eintreten der Rotfarbung bemerkt, und erhalt bei dieser Temperatur so lange bis die Gasentwicklung aufhört (ca. 30 Minuten); dann wird die erkaltete Mischung, ohne zu kühlen, in kaltes Wasser gegossen, die Flüssigkeit dekantiert und die voluminöse braune Fallung nochmals mit Wasser ausgekocht, um so die unveranderten Ausgangsmaterialien, abfiltriert und getrocknet. Hierauf wird der Farbstoff mit kochendem Alkohol in Lösung gebracht und daraus umkrystallisiert. Die Ausbeute betragt 15 g.

16.21 mg.	Sbst:	41.30 mg.	CO_2	4.45 mg.	H_2O
$C_{14}H_8O_4$	Ber.	C 70.0 %		H 3.30 %	
	Gef.	C 69.6 %		H 3 10 %	

Rote, rhomische Nadeln vom Schmelzpunkt 289°. Es sublimiert in orangeroten Nadeln. Sehr charakteristisch ist die Farbung ihrer alkalischen Lösung, in konzentrierten Zustande ist dieselbe diese purpurrot; im auffallenden Licht rein blau, durch Verdünnen geht die Farbe in blauviolett über.

ON THE DETERMINATION OF THE COLLOIDAL SUBSTANCES IN ALCOHOLIC BEVERAGES WITH THE INTERFEROMETER.

By Teizo TAKAHASHI and Toshinobu ASAI.

(Received Jan. 18th., 1927.)

Formerly one of us (T. Takahashi) and Yoshinobu Omachi (Journ, of

the Agric. Chem. Soc. of Japan. Vol 1. No. 1.) reported that the colloidal substances in alcoholic beverages were determined by means of the Löwe's interferometer, with special reference to the analytical percentage of the actual colloidal substances present. Further investigations by the same instrument have been done with respect to the colloidal substances contained in "Moto" and "Moromi" the mash of "Saké."

First we ascertained the power of adsorption of the animal charcoal (Merck's animal charcoal, extra pure). As the substances to be adsorped, such common colloidal substances, as dextrin and peptone and some non-colloidal substances, found always in the alcoholic beverages, were selected.

50c.c. of 0.1 % aqueous solution of each of these materials were added 0.5g. of animal charcoal, shaken for 30 minutes and filtered.

Of these filtrates "Colloidal Number" was found by the way as already stated. The results of the experiments were as follows :–

TABLE. No. 1.

Materials.	%(aqueous sol.)	"Drum Number."	"Colloidal Number."	
Dextrin. (Merck)	0.10	100	93	
Maltose. (Kahlbaum)	0.10	103	52	
Glucose. (Merck.)	0.10	104	15	
Peptone. (Witte.)	0.10	101	94	
Alcohol.	2.0	911	70	
Saccharose.	0.10	108	46	(T. Takahashi and Y. Omachi ; Journ. of the Agric. Chem. Soc. of Japan. Vol. 1. No. 1.)
Glycocoll.	0.10	121	2	
Glycerin.	0.79	602	22	
Succinic acid.	0.19	157	73	

As is seen from the table, dextrin and peptone were most adsorptible and maltose, glucose, saccharose and alcohol were so to some extents. (Especially with maltose such a high "Colloidal Number" as 52, was given, as about a half that of dextrin.) Glycerin, succinic acid and glococoll were almost adsorped.

From the results above given, not only the colloidal substances but also the non-colloidal substances were adsorped in some measure, so the "Colloidal Number" which in accordance of an assumption, being absolutely concerned with the actual quantity of the colloids present in alcoholic beverages, were never been obtained so far as only this instrument gets the place. [One of

us (T. Takahashi) already proposed[2] the application of the ultramicroscope to see whether the colloidal substances are completely adsorped or not by the treatment. The details of these facts are to be reported before long.]

Nevertheless, we found out by this investigation a beneficial fact that the "Colloidal Number" is almost proportional to the actual amount of colloids in certain cases, at least, so in the case of "Moto" and "Moromi" of "Saké." The data are shown in the reference table (Table. No. 3).

For the determination of the colloidal substances contained in "Moto" and "Moromi" of "Saké" we selected ten periods. The dilution of the sample was respectively done according to the concentration of colloids present in each period.

In many cases they were diluted with ten times of its volume of distilled water and in another cases twenty times' dilution were taken. Animal charcoal, in various quantities, was added to 25c.c. of the diluted sample and conducted as above stated.

The "Colloidal Number" are almost equalized to hundred times of the number of grams of the actual colloids present in 100c.c. of the sample.

The following table shows the suitable quantities of animal charcoal for the determination of colloids in "Moto" and "Moromi" of "Saké", assuming dextrins and proteins were the main colloidal substances in the beverage.

TABLE. No. 2.

Stages of the sample taken.	"Futsumoto" No 1. In "Moromi" "Sokujio moto" No. 1. were taken in this place.				"Yamaoroshi haishi moto" No 2.			
	Dilution.	Animal-charcoal (g. in 25c.c. of dil. sample.)	"Colloidal Number"	Protein+Dextrin (g in 100c.c. of the sample.)	Dilution.	Animal-charcoal	"Colloidal Number"	Protein +Dextrin.
Moto "Wakitsuki" (Beginning)	20	0.3	349	7.0796	20	0.2(?)	—	4 1616
"Moto wake" (Separation)	10	0.3	300	2.4280	10	0.3	326	3 3000
"Jyukusei" (Matured moto)	10	0.2	269	2.6172	10	0 2	267	2.5200
Before "Shiyo" (Main fermentation)	10	0.3	230	2.4132	10	0.2	252	2.3720
Moromi Before "Tome"	20	0.2	196	4.1108	20	0.2	158	3.0765

(2) Journ. of the Agric. Chem. Soc. of Japan. 1925.

"Kuchiuchi"* (Main mash)	10	0.7	502	4.7307	10	0.8	541	5.7118
12 days after "Tome"	10	0.6	379	3.4687	10	0.7	452	4.5100
Before "Shiboriage" (Pressing)	10	0.3	248	2 3670	10	0.3	263	2.6246
Before "Hiire" (Pasteurisation)	10	0.1	129	1.1266	10	0.1	140	1.5588
After "Hiire"	10	0.1	127	1.2036	10	0.1	147	1.6352

△ "Tome" is the final process of the addition of the raw materials in the main fermentation.
* "Kuchiuchi" is a process of the mixing of "Moromi" mash.

The relation between the "Colloidal Numbers" and the "Drum Numbers" in the case of "Moto" and "Moromi" of "Saké" are shown in the following table :–

TABLE. No. 3.

Stage of the sample taken.	No.	Animal charcoal (g in 25c c. of the dil. sample)	"Drum Number"	"Colloidal Number"	"Drum Number" / "Colloidal Number"	Alcohol+Sugar / Dertrin+Protein
"Moto" wake (Separation of "Moto" mash)	F. 1.	0.3	1660	300	5.53	7.60
	Y. 2.	0.3	1663	326	5.10	4.98
"Jyukusei"	F. 1.	0.2	1506	299	5.59	6.28
	Y. 2.	0.2	1401	267	5.24	6.01
"Kuchiuchi"	S. 1.	0.7	1568	502	3.12	3.09
	Y. 2.	0.7	1558	501	3.10	2.26
12 days after "Tome"	S. 1.	0 7	1363	413	3.30	5.06
	Y. 2.	0 7	1437	452	3.17	3 87
Before "Shiboriage" (Pressing)	S. 1.	0 3	1238	248	4.99	7.74
	Y. 2.	0.3	1294	263	4.92	7.24
Before "Hiire"	S. 1.	0.05	1187	94	12.62	17.29
	Y. 2.	0 05	1298	122	10.63	12.82
After "Hiire"	S. 1.	0 1	1174	127	9.24	15.62
	Y. 2.	0.1	1279	147	8.70	11.83

F. 1. = "Futsumoto" No. 1.
Y. 2. = "Yamaoroshi haishi moto" No. 2.
S. 1. = "Sokujyo moto" No. 1.

Therefore, in comparison with the contents of the crystalloids such as sugars and alcohol, if the contents of the colloids were relatively larger the "Colloidal Numbers" were comparatively larger viz. there may not occur any error whatsoever caused by the adsorption of the crystalloids, and even in the reverse case the "Colloidal Numbers" show always proportional to the actual contents at least in Saké mash.

STUDIES ON ACIDS FORMED BY RHIZOPUS SPECIES. Part III. The Formation of d-Gluconic Acid.

By Teizo TAKAHASHI and Kinichiro SAKAGUCHI.

(Received Dec. 9th, 1926)

The occurrence of some kinds of organic acids, which are unextractive by ether, but whose lead salts are precipitable by alcohol (50–60%), in the culture medium grown with a certain species of Rhizopus was reported in the previous article.[1] To isolate and identify the acid, the lead salt yielded from about 10 liters of the medium, was treated by the current of SH_2 to set the acids After a complete removal of excess of SH_2, the acids were collected as calcium salts. The dry calcium salts were then treated by a small quantity of water, to get into the solution a part of these calcium salts.

To the solution thus obtained, an excess of alcohol (98%) was poured in and by this means there separated out a precipitate, which gave the characteristic colour reactions of lactic and gluconic acids.[2]

The precipitate was collected on a filter, washed several times with alcohol (98%) and at last with methyl alcohol, which dissolved very easily calcium lactate, leaving gluconate behind it. Thus we were able to isolate from the product all of the calcium gluconate, which was recrystallised from 30% alcohol in the characteristic needles.[3] It was identified by its specific rotatory power and calcium contents as follows :–

Specific rotatory power.

Substance taken 0 3227 g. Solvent : water.

$\alpha = +0.37°$ $l = 2$. d. m. $t° = 17°C.$

$$[\alpha]_D^{17} = \frac{\alpha \times 100}{c \times l} = \frac{+0.37 \times 100}{3.227 \times 2} = +5.73°$$

[After Herzfeld: A. 2200, S. 345, 347, 350.
$[\alpha]_D$ = + 5.°8 — + 5.°97 (c = Ca. 2) and
After Bertrand: A. Ch. [8], 3, 275,
$[\alpha]_D^{20}$ = + 6.°13′ (c = 5.0)][4]

Contents of calcium:

Substance taken		0.2471 g. (drined at 120°C)	
$CaCO_3$		0.0575 g.	
Ca.	0.0230 g.	found	9.31%
		calc.	9.37%

(1) This Journal. Vol. II. No. 20. 1926.
(2) This Journal. Vol. I. No. 11. Takahashi and Sakaguchi's article.
(3) It was about 0.4g.
(4) Beilstein. IV. Aufl. III. S. 514.

STUDIES ON ACIDS FORMED BY RHIZOPUS SPECIES. PART IV.

By Teizo TAKAHASHI and Toshinobu ASAI.

(Received. Jan. 25th., 1927.)

A. Formation of Fumaric, Succinic, Formic and Acetic acids, and of Ethyl Alcohol from Gluconic acid.

B. Formation of Succinic acid from Acetic acid.

In the first communication[1] on this subject the authors reported that a certain species of Rhizopus produced fumaric acid and ethyl alcohol not only from carbohydrates but also from tartaric acid. However, the latter acid can not be regarded as the primary cleavage product from glucose, therefore the authors studied the mechanism of the degradation of glucose more carefully, and observed, in their recent experiment,[2] that some species of Rhizopus produced gluconic acid from glucose. So they investigated further to see whether gluconic acid is decomposed into simpler acids by Rhizopus. For this purpose two species of Rhizopus, i. e. Rhiz. G. 34 and G.36 Yamazaki were cultivated in the solutions containing gluconic acid, and after being kept at 25–30° for several weeks, the culture solutions were analysed, and the presence of fumaric, succinic, formic and acetic acids as

(1) J. Agr. Chem. Soc. of Japan 2 No. 5.
(2) Ibid. 3 now in press.

well as ethyl alcohol was positively proved. So there is no doubt that gluconic acid is the intermediate product between the above mentioned acids and glucose.

At the same time the formation of succinic acid from acetic acid, by linking two molecules of the latter together, was also confirmed.

The culture media used for this experiment were prepared by dissolving either 0.8g. peptone or 0.8g. ammonium sulphate, and 5g. calcium gluconate, a little mineral matter[3] in 200c.c. water. The solutions were then slightly acidified with free gluconic acid in order to favour the growth of the fungus. After inoculating the fungus, the culture solutions ware kept at the temperature of 25–30° for 45 to 75 days, then they were filtered and subjected to analysis with the following results :–

	I	II	III	IV	V	VI	VII	VIII
Fungi	Rhiz. G. 34.	〃	〃	〃	Rhiz. G. 36.	〃	〃	〃
The source of nitrogen	Peptone 0 4%	〃	am-sul. 0 4%	〃	Peptone 0 4%	〃	Am-sul. 0.4%	〃
Days of culture	45	60	48	60	55	60	70	75
Aldehyde (Schiff's reaction)	+	+	+	+	+	+	+	+
Alcohol	±	±	±	±	±	±	±	±
Acetic acid (as Ca-salt) (g.)	0.005	0.011	0.0418	0.0323	0.279	0.022	0.035	0.026
Formic acid	+	+	+	+	+	+	+	+
Fumaric acid (g.)	0.026	0.089	0.024	0.096	0.023		0.010	0.045
Succinic acid (g.)	/	0 016		0.052	0.087	0.030	0.042	0.035
Gluconic acid undecomposed	1.96	1.55	1.09	0.62	2.07	2.19	3.06	2.13

The mechanism of the formation of these organic acids from gluconic acid may most probably be represented as follows :–

I. (a) $2\ \mathrm{COOH(CHOH)_4CH_2OH} + O_2 = 2\ \mathrm{COOH(CHOH)_2COOH} + 2\ CH_3.COH + 2\ H_2O$

(b) $\mathrm{COOH(CHOH)_2COOH} = \mathrm{CH_2.COOH\ CH_2.COOH} + O_2$

(c) $\mathrm{CH_2.COOH\ CH_2.COOH} = \mathrm{CH.COOH\ CH.COOH} + H_2$

(3) Ibid 2 No. 5.

II. (a) $2\ CH_3\cdot COH + O_2 = 2\ CH_3\cdot COOH$

(b) $2\ CH_3\cdot COOH = \begin{matrix}CH_2\cdot COOH\\ CH_2\cdot COOH\end{matrix} + H_2$

(c) $\begin{matrix}CH_2\cdot COOH\\ CH_2\cdot COOH\end{matrix} = \begin{matrix}CH\cdot COOH\\ CH\cdot COOH\end{matrix} + H_2$

For the detection and identification of the above mentioned acids, the culture solution was first distilled, and formic acid in the distillate was detected by the reducing property of a solution of potassium bichromate in nitric acid (violet blue colouration) and by that of ammoniacal mercuric chloride solution. Acetic acid was detected as acetone by the dry distillation of a small quantity of the calcium salts prepared from the distillate. The acid itself was also isolated in a pure state by the redistillation of the distillate which was previously freed from formic acid by treating with a mixture of potassium bichromate and sulphuric acid. Further, the silver salt was prepared and analysed ;-

Substance taken = 0.1049 g. AgCl = 0.09 g. Ag = 0.0677 g.

$C_2H_3O_2$ Ag. Calc. 64.64 % Ag Found 64.58 % Ag.

For the isolation of fumaric and succinic acids the culture solution was repeatedly extracted with ether, the ethereal extract was evaporated and the mixed acids were then converted into the calcium salts which were then treated with water in order to remove calcium gluconate, and the residue consisting of the mixture of calcium fumarate and succinate was taken up in ether again after acidifying with sulphuric acid. By shaking the ethereal extract with water, succinic acid went into aqueous solution, while fumaric acid remained in ethereal layer. The fumaric acid obtained by evaporating the ether melted at 285° in a sealed tube and gave positive colour reactions[4] to resorcinol and β-naphtol in presence of sulphuric acid.

Number of titration :- Substance taken 0.1133 g.

$\begin{matrix}CH\cdot COOH\\ CH\cdot COOH\end{matrix}$ n/10 NaOH Found 19.8 c c.

Calc. 19.6 c c.

Silver fumarate $Ag_2C_4H_2O_4$ Substance taken 0.2308 g.

AgCl 0.2003 g. Ag 0.1508 g.

Ag Found 65.34 %

Calc. 65.43 %

Succinic acid : M. P. 183°C (not corrected)

Number of titration : Substance taken 0.0443 g.

$\begin{matrix}CH_2COOH\\ CH_2COOH\end{matrix}$ n/10 NaOH Found 7.0 c.c.

Calc. 7.1 c.c.

(4) J. Agr. Chem. Soc. of Japan 1. No. 14.

Silver succinate	$Ag_2C_4H_4O_4$	Substance taken		0.1124 g.
	AgCl 0.0969 g.	Ag	0.0729 g.	
	Ag	Found		64.89 %
		Calc.		65.02 %

From the culture of calcium acetate medium at 25–30°C for 60 days, succinic acid identical with the above description was obtained.

A NEW BUTYL AND ISOPROPYL ALCOHOLS FERMENTATION.

By Kisaku MORIKAWA.

(Received Feb. 8th., 1927)

The production of higher alchols for use as solvents and in many technical developments has made great headway in the past ten years. The work of Speakman in Canada, Northrup and Fred in America and of a number of investigators in Europe has been especially worthy of mention.

It is the belief of the author of this investigation that many fermentations as yet undesscribed may have technical significance and find use in industry. The present research represents one study of this character. In this I have dealt with the fermentations of Kojimash, much used in my country (Japan) and which contains large amounts of fermentable sugars.

While making some experiments in this field, I isolated certain organisms which develop and produce fermentation under aerobic conditions with the formation of what appeared to be butyl and isopropyl alcohols as the chief products of the fermentation. Continued work with pure cultures led to this investigation, in which I have described the morphology and physiology of a new organism, and have recorded the results of many studies of its fermentation reactions on various kinds of subtrates.

Media –For these studies the standard media of the American Bacteriological Society were usually employed, in addition to which I have used Koji broth, Koji-agar, malt extract broth and its agar, 5% corn meal mash with calcium carbonate and other kinds of sugar broths.

STUDIES ON THE MICROORGANISMS.

Morphology–Vegetative cells appear in single rods, in pairs or in chains, having rounded ends, and enclosing granules in their cell especially in old

stages. Size of rods shows somewhat wide variability, 2 to 5 μ, majority about 3 μ in length, 0.7 to 1.5 μ, majority about 1.0 μ in width. Sporangia appear slightly swollen and with an ellipsoidal or clavated structure enclosing a spore in each cell, 2 to 5 μ, majority 3 μ in length, 1.25 to 1.5 μ, majority 1.25 μ in width. Spores are thick walled cells located at center or somewhat eccentric and having ellipsoidal structure, 1.8 to 2.5 μ, majority 2 μ in length, 0.6 to 1.25 μ, majority 1.0 μ in width. In the vegetative stage motility is very active in broth or agar cultures especially at a young stage having flagella. In old cultures it shows quite a variability of forms, swollen or somewhat clavated, and there appear difficulty stainable cells for most dyes especially methylene blue.

Cultural Characteristics.

Agar stroke . With plain, Koji or malt agar, it shows good growth having echinulate, slightly raised elevation, glistening luster, smooth or little contoured surface, opaqueness, and butyrous consistency.

Gelatin stab Liquefied medium comparatively rapidly showing good growth especially at the top.

Potato . Shows good growth with dirty white luster. Especially in the older stage it has a tendency to develop brownish colour and appears butyrous consistency of colony.

Nutrient broth : Produce good growth, strong clouding and abundant compact sediment.

Milk : Forms gas and acid, coagulating casein, afterwards digests protein very weakly. In litmus milk nearly the same character is observed without any injurious effects of litmus added. The colour of litmus is reduced gradually within a week.

Agar plate In plain agar medium it grows rapidly appearing as circular colonies margined irregularly, smooth or rough surface, flat elevation, and shows finely curled internal structure.

Starch digestion : On starch agar plate culture no marked digestion is recognized, but with thick corn meal mush it reduces the viscosity forming gas and watery liquid.

Gas production : With arabinose, xylose, rhamnose, glucose, fructose, galactose, lactose, raffinose, inuline, mannite, dulcite, adonite, glycerin, and inosite broths, little or much gas is produced depending on the kind of substances.

Indol production : With peptone water or nutrient broth no indol is formed.

Hydrogen sulphide production : With various kinds of sodium acetate

media no hydrogen sulphide is recognized.

Nitrate reduction and ammonium production : With potassium nitrate broth or agar, nitrate is reduced into nitrite, besides ammonia is formed.

Temperature relations : Optimum 30°–40°C., minimum 10°C., maximum 50°C.

Relation to oxygen : Good growth in aerobic or partial anaerobic condition.

Relation to reaction of medium : Optimum pH 70. to pH 60.

Endo's agar stab : Bright red colouration, moderate growth along the needle track; slight gas is formed.

Methyl red test : Strikingly positive reaction is exposed.

The products of fermentation : Raw starch is not affected by this organism, but sugars are readily fermented yielding normal butyl and isopropyl alcohols as the chief end products. Small quantities of acetic and butyric acid are produced. The gas evolved during fermentation consists of H and CO_2, the hydrogen greatly exceeding the CO_2 in volume, and the ratio varying at different periods of the fermentation. Under semianaerobic conditions, that is, with reduced oxygen tension, small quantities of acetone are found in the distillation products.

Careful comparative studies have demonstrated that the organism is unlike any other yielding similar products which have previously been described. Most of the organisms which yield alcohols, acetone and fatty acids which have been studied up to this time may be divided into two groups.

(1) Those which produce higher alcohols and acetone under anaerobic conditions.

(2) Those which yield ethyl alcohol and acetone under aerobic or facultatively anaerobic conditions.

I have found no ethyl alcohol, under any of the conditions studied.

In view of these differences in morphology and physiological behavior, I believe this to be a new species and have given it the provisional name, Bacillus Technicus, n. sp. Prescott and Morikawa.

Further Studies on Biochemistry of the Organism.

To obtain more detailed information of physiological features, further experiments such as sugar reactions, change of gas volume which may be produced, acidity changes during incubation, and injurious effects of products on bacterial growth have been studied. All sugars tested have been consumed causing much or little gas evolution and increasing acidity. Of the pentoses. rhamnose gave little gas and alkaline reaction after seven days

fermentation, while arabinose and xylose were strongly acid and gave abundant gas formation. All the monosaccharides and disaccharides gave high acidity and much gas. The polyatomic alcohols adonite, dulcite and mannite and glycerin gave little gas. With adonite and dulcite the final reaction was alkaline, while with glycerin and mannite it was slightly acid. The alkaline reaction with adonite and dulcite is apparently the result of action on the nitrogenous constituents of the medium by which it is broken down to amines and ammonia.

Studies on the occurrence of aldehydes as an intermediate product were positive to Schiff's test in all cases. It may be supposed that the sugars are converted into aldehydes, which is instantly transformed by reduction into alcohols or by oxidation to corresponing acids.

In the early hours of the fermentation vigorous gas production and the high percentage of hydrogen in the gas evolved may be noted. This is probably due to the greater solubility of the carbon dioxide in the medium. At the intermediate period of duration the low percentage may appear, which is owing to the saturation of the solution by carbon dioxide.

An approximate ratio of hydrogen and carbon dioxide resulted 4.5 to 6.4 showing somewhat wide variation which may depend on the condition of media and the stages of fermentation tested. As to acidity change during fermentation in my process, the hydrogen ion change may show somewhat undulatory changes, that is, a rise and fall of concentration, while the titrable acidity change appears to be quite identical with that noted by others with B. granulobacter pectinovorum. In my investigations it was found that the titrable acidity may increase comparatively quickly, depending on the conditions, until it reaches the maximum and then it may decrease gradually to the minimum. There is not an acute increase and decrease of the acidity as in the case of B. granulobacter pectinovorum with corn mash.

This organism appears to be very sensitive to conditions in the medium. If there are some injurious substances in a prepared mash, the bacterial growth may be prevented. For example, with too high acidity, excessive sugar concentration or presence of a certain amount of alcohols, the bacterial growth may not appear. Although the organism here described is very sensitive to the hydrogen ion concentration at the starting point of fermentation, it may be active until about pH 4.6 with Koji mash. On the other hand, in dextrose broth this organism will grow very poorly, if at all, in pH 5.0 or a stronger acidity. At the end of fermentation, normally a fermented mash will show pH 4.4 to 4.2, or somewhat low hydrogen ion concentration, and titrable acidity 3.0 c.c. of n/10 sodium hydroxide solution per 10c.c. of fermented mash. In both cases, the results may be affected by the presence

of neutralizing agents. Among organic acids, which were supposed to be injurious to bacterial growth, lactic acid displayed a strongly inhibitive action, and butyric and acetic acids had weaker action in preventing growth or fermentation. This may be explainable, since the latter two acids have smaller ionization constants than the former. By an addition of about one percent of butyl alcohol before inoculation to dextrose broth, no fermentation will occur or it may be retarded, but ethyl and isopropyl alcohols may not be so harmful as butyl alcohol. The effect of their own metabolic products which are obtained from old cultures by filtering through a Berkefeld filter may be harmless in the Koji mash within certain limits.

A fermentation process has been developed, which is quite different from others now in use in which starch is converted into sugars by enzyme action of molded rice. The sugars thus produced are converted into butyl and isopropyl alcohols by the B. technicus under aerobic conditions. The consumption of sugar is most rapid in the earlier stage of fermentation, and afterwards it may show a slow decrease of the sugar content. These changes occurring somewhat in correlation with the gas production and acidity of the mash. On the contrary, the formation of alcohols may appear especially in the final stage of a fermentation. Although much unutilized sugar may remain in the fermented mash at the end of a fermentation, a good yield may be obtained in a fairly concentrated sugar mash, 12% of sugar as glucuse in a mash being most favorable.

From the many experimental results it was found that 100 grams of sugar as glucose produced 30 grams of alcohol, and assuming that two mols of butyl alcohol and one mol of isopropyl alcohol may be formed from three mols of glucose, but sometimes the ratio of butyl and isopropyl alcohols showed 3 : 1. The yield of alcohols presumably is mostly affected by the concentration of sugar, total volume and hydrogen ion concentration of the mash. Normally 20c.c. or somewhat more alcohols may be obtained from one liter of mash. A specially high percentage yield cannot be expected since the solubility of butyl alcohol is limited, and because of the inhibiting nature of alcohols for the organisms. The determination of products such as alcohols and acids was made by testing their physical and chemical properties. Especially the alcohols were confirmed by ester formation with 3.5 dinitrobenzoic acid, and furthermore, isopropyl alcohol was tested by oxidation and then condensation with benzaldehyde. Acids were identified as toluides with paratoluidine or as paranitrobenzyl esters.

A NEW METHOD OF COLORIMETRIC ESTIMATION OF HISTIDINE. PART II.

By Kôzô Suzuki and Yoshio Kaishio.

(From the Chemical Laboratory of Imperial Zootechnical Experiment Station, Chiba.)

(Received Feb. 2nd., 1927.)

In our previous communication (this Jour. Vol. 2, 77, 1926), we have made a report on a method of colorimetric determination of a small amount of histidine by application of Totani's reaction. Since then we have tried to improve the method and succeeded in discovering a new sensitive reaction giving the same permanent golden yellow colouration, not by going all through the complicated Totani's reaction, but by simply treating a histidine solution with sulfanilic acid, making acidic with sulfuric acid, and then making it alkaline by caustic soda or sodium carbonate.

This reaction has been utilized for the determination of histidine with very satisfactory result.

Totani's reaction for histidine consists in carrying out diazo-reaction first and then reducing the product with strong hydrochloric acid and zinc dust, but diazobenzene-sulfonic acid becomes hydrazine or decomposes into sulfanilic acid and ammonia by reduction, while amino acids are generally not reducible in their free states, it being only reduced to aldehyde, when their esters are strongly cooled and treated with natrium amalgam.

Assuming, therefore, that Totani's reaction is, after all, the reaction between histidine and sulfanilic acid, we have proceeded as follows:

So an aqueous solution of histidine is added (a) some excess of 2 % sulfanilic acid solution in 10 % sulfuric acid, and (b) concentrated sulfuric acid enough to make its concentration in the solution 11–15 %. When the solution is well shaken and then made alkaline by the addition of caustic soda or sodium carbonate, the solution gives a golden yellow colour just as in the case of Totani's reaction.

This reaction is applicable to the estimation of a small amount of histidine for following reasons:

(1) This colouring reaction is sensitive and characteristic to histidine. However as phenol gives rise to a similar colouration, the method cannot be used for either detection or estimation of histidine in presence of phenol.

(2) The golen yellow colour by this reaction is permanent for a considerable time,

(3) When the concentration of sulfuric acid is made 11–15 %, the excess of other reagents used, i. e. sulfanilic acid, caustic soda or sodium carbonate, do not affect the intensity of colouration in the slightest degree.

(4) The intensity of the golden yellow colour is directly proportional to the amount of histidine.

(5) The colour can be compared with that of 1/100 normal potassium bichromate solution, as standard.

The relation between the amount of histidine present and the thickness of the layer of potassium bichromate standard solution is exactly the same, as in our previous report, i. e.,

1 mm. layer of $K_2Cr_2O_7$ = 0.4028 mgs. of histidine.
" = 0 019032 mgs. of histidine nitrogen.

The computation of unkown amount of histidine can, therefore, be made by mean of the followiding equation:

$$X = \frac{0.40248 \times d}{D}$$

$$X' = \frac{0.010932 \times d}{D}$$

where X = mg. of histidine in 1 c.c.
X′ = mg. of histidine nitrogen in 1 c.c.
D = number of m.m. of the histidine solution.
d = number of m.m. of 1/100 normal $K_2Cr_2O_7$ solution

As stated above, phenol gives a similar colouration to the solution when subjected to this reaction, so this method is inapplicable to the estimation of histidine when phenol is present, but there could be no phenol among the decomposition products of proteins, nor any substance which may similarly colour the solution through the same treatment, we can very safely apply this reaction to the estimation of histidine in proteins. Besides our new method has further advantage over Totani's reaction, as by the latter, it is necessary to separate previously hexon bases by mean of phosphotungstic acid, because through Totani's reaction, tyrosine gives a pink colour to the solution, whereas, by our new method, even tyrosine gives no colour, so that we can directly proceed to determine the amount of histidine in hydrolyzed solution of proteins, after its decolourization by mean of charcoal.

Furthermore, when Van Slyke's method is used, at least 3–6 grms of proteins is required for the quantitative determination of histidine in it, but if our method is adopted a small quantity less than 1 g. of protein is ample, and by very simple treatment, as described above, a very satisfactory result could be quickly obtained.

ON THE PHYSIOLOGY OF RHIZOPUS SPECIES. PART I.

THE RELATION BETWEEN THE CONDITIONS OF THE GROWTH OF THE FUNGUS AND THE PRODUCTION OF ACIDS AND ETHYL ALCOHOL.

By Teizo TAKAHASHI and Kinichiro SAKAGUCHI.

(Received Feb. 15th., 1927.)

The surface growth of the fungus in the culture medium is that one of the commonest and very naturally it is the most favourable one. On the other hand, the growth in the liquid viz. the immersed growth is always inferior to the surface growth. In the former case the production of the acids predominates and in the latter case that of alcohol is more pronounced upon the whole, and in the average by Rhizopus species we observed the fallowings :-

	Surface growth.	Inner growth.
Acidity.	2.15 c c.	1.62 c.c.
Alcohol. (w. %)	0.34	1.18

The percentage of the increasement of alcohol in the case of the immersed growth over that of the surface growth during eight days was 31 %, which attained to about 128 % after a period of 17 days culture. Even in the case of the immersed growth, if we substitute the fermenting bung instead of cotton plug in the mouth of the flask there occured about one-seventh decrease in acidity and 2% less in alcohol production than the latter case.

Experimental.

Rhizopus G. 34 was used through the experiments.

The first culture medium consited of:- 5g. glucose, 0.15g. $(NH_4)_2SO_4$, 0.008g. KH_2PO_4 and K_2HPO_4, 0.005g. $MgSO_4$ and $CaCl_2$, trace NaCl and Fe_2Cl_6, 50c.c. distilled water.

In 7 days after seeding the growth attained to cover the whole surface of the medium and in that stage about the half of the culture flasks the surface growth was immersed into the liquid with the sterile rod of platinum. After the said treatment, twice in a day, the flasks were shakened gently to set the growth in the immersed state and after a period of 24 days from the begining of the immersed culture, the contents of flasks were analysed.

The temperature of the environment was held at from 25–30°C during the culture. The results of the analyses were :–

		Weight of the growth (g.)	Acidity* c.c. of $^{n}/_{10}$ NaOH to neutralize each 5c.c. of the medium.	Alcohol. w. %
Surface culture.	No. 1.	0.308	2.2	0.32
"	No. 2.	0.251	2.9	0.72
"	No. 3	0.303	2.3	0.22
"	No. 4.	0.282	—	0.34
"	No. 5.	0·256	1.9	0 42
Average.		0 286	2.15	0.34
Immersed culture.	No. 6.	0.168	1.5	1.60
"	No. 7.	0.284	1.7	0.90
"	No. 8.	0.218	1 6	1.06
"	No. 9.	0.250	1.7	1.16
Average.		0.237	1.62	1 18

* The acidity of the original medium was. 0.4 c c.

In the second case $(NH_4)_2SO_4$ in the medium was changed to glycocoll thus ;– 10g. glucose, 0.5g. glycocoll, 0.015g. K_2HPO_4 and KH_2PO_4, 100g. distilled water, and the other ingredients such as $MgSO_4$, $CaCl_2$, NaCl and Fe_2Cl_6 were given in a similar dosed as much as in the first case.

The results of the analyses of the culture at the same temperature as in the first experiment were shown below :–

Cultures	Days of culture.		Weight of the growth. (g)	Acidity c.c. of $^{n}/_{10}$ NaOH to neutralize each 5c.c. med.	Alcohol.		Sugar consumed. (g.)
	Before immersion	After immersion			w. %	%. of increase-ment.	
A. a.	21	—	0.701	95.	0.61	100	8.1
A. b.	21	—	0.751				
B. a.	13	8	0.592	9.0	0.80	131	8.3
B. b.	13	8	0.612				
B. c.	13	—	0.510	9.1	0.56	—	—
C. a.	4	17	0.483	5.4	1.38	228	9.0
C. b.	4	17	0.505				
D.	35	—	0.078	1.3	1.60	98	4.1

[A. Control culture. B. C. Immersed culture. D. The cotton plug was replaced by fermenting bung.]

ON THE PHISIOLOGY OF RHIZOPUS SPECIES. PART II.

THE RELATIVE QUANTITIES OF THE PRODUCTION OF ETHYL ALCOHOL AND CARBONDIOXIDE.

By Teizo TAKAHASHI and Kinichiro SAKAGUCHI.

(Received Feb. 15th, 1927.)

In the normal viz. surface growth of the culture of Rhizopus species, the ratio of the production of carbondioxide to alcohol is decidedly greater than that of the case of the fermentation by yeast. The cause of the predominancy of the formation of carbondioxide over alcohol must be ascribed to many lines of descriptions. The formation of the rather large quantities of organic acids must be one of these causes and side by side the redecomposition of alcohol produced, into CO_2 and water, must recconed upon as another one. In addition to these causes the redecomposition of fumaric acid into lactic acid and CO_2 could not be neglected as one of them.

In our researches, we selected the special condition, good enough to the atmost production of alcohol. The culture indicated in the part I viz. the immersed culture is one of the most good conditions available for it.

The results are tabulated below :-

Cultures.	Carbon dioxide (g.)		Alcohol. (g.)	CO_2 : C_2H_5OH.	Acidity. c.c. of $n/10$ NaOH. to neutralize 5c.c. of the medium.	Acid (g.) as fumaric acid.	Volatile acid. Acidity c.c. of $n/10$ NaOH. for 5c.c. medium.	Sugar consumed. (g.)
	Determ. by w.*	Determ. by KOH-bulb.						
No. 1.	1.435	1.402	1.56	91.98 : 100	8.4	0.053	0.2	3.25
No. 2.	1.294	—	1.34	96.54 : 100	9.6	0.056	—	3.02
No. 3.	1.411	—	1.52	92.83 : 100	7.8	0.049	—	3.15
Average.				93.78 : 100				

* Determined by the difference of the weight of flask before and after the experiment.

For the comparison of these results to that of already known, the table below is given :-

	CO_2	C_2H_5OH.
Mucor racemosus (Kostgtsew[1] and others)	100	98
// //	100	99
Aspergillus niger.	100	91
//	100	92
//	100	94
Yeast. (Paster).	95.3	100 [46.4 % : 48.67%]
// (Todlbauer).	95.6	100 [46.54% : 48.67%]
// (Kosutany).	98.9	100 [47.50% : 48.08%]

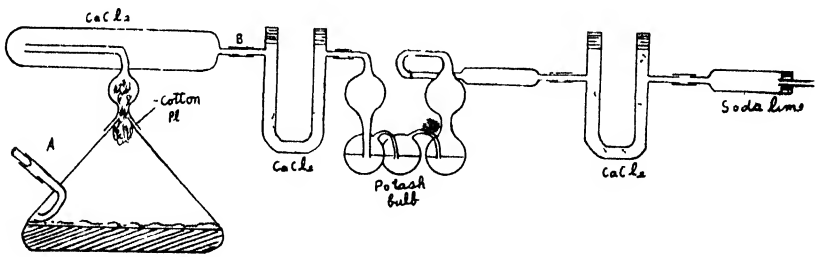
As seen from the tables, the authors are induced to point out that the fungus of Rhizopus species behaves very similar way of the alcoholic fermentation, which takes place by yeast.

Experimental.

Rhizopus species used by this experiment was the same one as in the part I viz. Rhiz. G. 34. Culture medium : glucose 6g., Pepton 0.3g., solution of mineral matters 60c.c.

The solution of mineral matters consisting of; distilled water 1000c.c., K_2HPO_2 and KH_2PO_4 each 0.15g., $CaCl_2$ and $MgSO_4$ each 0.1g., Fe_2Cl_6 and NaCl each trace.

For the culture, a special flask (see the sketch), provided with all appliances suitable for an aseptic working, was used for the benefit of the accurate determination of carbon dioxide evolved during the course of fermentation.



The seeding of the fungus was done from the side tube of the flask (marked A) and kept at the temperature of 25–30°C during two weeks and for the sake of the complete growth of the fungus, twice every day about 20 minutes a fresh air freed from moisture, CO_2, and the germs of microbes is introduced shaking the flask gently in each times. After the complete growth viz. the film covering the whole surface of the medium, the fluid

(1) Kostytschew u. Andere. Woch. f. Brau. 1926. No. 23, S. 259.

under the film is decanted and washing several times with the sterile distilled water, until there remains any indication of the presence of acids and sugars, culture medium anew is introduced from the side tube as done in the begining.

Carbon dioxide evolved was determined from the difference of the weight of the flask, detatched from B, (see the sketch), at the begining of the experiment and the end of the growth of the fungus.

In another case it was absorbed by potash bulb. In either case, to ensure the accuracy of the determination of it, the flask was wormed at about 70°C and a current of air freed from the moisture, CO_2 and the germs of microbes was introduced in to drive off the last traces of the carbonic acid charged in the medium, and in one case it was to be absorbed in the potash bulb.

ON THE PHISIOLOGY OF RHIZOPUS SPECIES. PART III.

THE EFFECT OF PHOSPHORIC ACID AND POTASSIUM FOR THE PRODUCTION OF ACIDS AND ETHYL ALCOHOL.

By Teizo TAKAHASHI and Kinichiro SAKAGUCHI.

(Received Feb. 15th., 1927.)

It is well known, that in the alcoholic fermentation of yeast the presence of an adequate quantities of both potassium and phosphoric acid in the culture medium activates or favours the growth of the organism to produce alcohol in an atmost quantity. Since this fungus produces acids rather in a large quantity, than pronounced by yeast, the authors proceeded to research on the effect of both potassium and phosphoric acid for the formation of not only for alcohol but also for organic acids, such as fumaric, succinic and lactic acids from glucose by the fungus.

The result attained was that the formation of alcohol by the fungus, Rhizopus G. 34, is rather favourable, when the doses of potassium and phosphoric acid are smaller than that of normal or common medium viz. medium which is the most favourable for the growth. As to the effect of

of phosphoric acid on the formation of the acids, just fumaric acid seems to be found in the largest quantity in normal medium; although other acids such as, succinic, malic and lactic acids have not found with the differences worth-mentioning whatsoever in all the cultures with different doses of phosphoric acid. On the other hand, the favourable effect of potassium to increase the production of acids was always ascertained, when we add the less doses of it to the media.

The table below represents the analytical data :-

Culture media.	Quantities of K. and P. in media.	Period of culture. (days).	Total acidity. c.c. of n/10 NaOH to neutral 5c.c of medium.	Fumaric acid in 100c.c. medium.				Succinic acid (g.) in 100c.c.	Lactic acid (g.) in 100c.c.	Malic acid (g.) in 100c.c.	Alcohol (g.) in 100c.c.	Sugar remained. (g.)
				As Ca-salt. (g.)	In ether-ext. (g.)	Totol fumaric acid (g.)	Yield against to sugar consum. %					
Normal sol.	K_2HPO_4 0.03g. KH_2PO_4 0.03g.	30	3.2	5 051	2.19	6 002	30.1	0.155	0.027	0.124	0.36	Trace.
Small dose of phospho-ric acid.	KCl, 0.03g. K_2HPO_4 0.005g.	49	2.0	0	1.43	1.43	15 09	0.175	0.032	—	1.30	10.5
Excess of phospho-ric acid.	KH_2IO_4 0 03g. K_2HPO_4 0.03g. Na_2HPO_4 0.2g.	30	5.4	3.87	1 72	4.64	23.15	0 162	0.028	—	0.48	0
Small dose of potash.	Na_2HPO_4 0 06g. KCl 0.005g.	49	3.5	5.37	3.77	7.21	39.8	0.805	0.050	0.27	0.70	1.62

Experimental.

The fungus used for the purpose was Rhizopus G.34. Yamazaki, and the temperature of the culture was 28–31°C.

The culture media were prepared with several different doses of potassium or phosphoric acid, as indicated in the above table, and the other constituents[1] common to all were;- glucose 20g., $(NH_4)_2SO_4$ 1g., $MgSO_4$ and $CaCl_2$ each 0.02g., Fe_2Cl_6 and NaCl each trace, $CaCO_3$ 6g., distilled water 200 c.c.

Fumaric acid. For the estimation of the acid, a part of it was separated as calcium salt, which appeared as crystalls already in the culture medium.

(1) The chemicals used for this preparation are all of the Maerk's brand.

This calcium salt was recrystallized from water and dried at 120°C. The other part dissolved in the medium was extracted as in a common way with the acidification by sulphuric acids after being concentrated the medium under the reduced pressure. The other organic acids than fumaric acid, in the ether extract, was dissolved by treating the mixture with a small quantity of water, remaining behind fumaric acid almost in a pure state.

Lactic acid. The filtrate from fumaric acid was neutralized accurately with $^{n}/_{10}$ baryta water and after evaporating under the reduced pressure to a thick mass, an excess of alcohol of 80 % (v), was poured in to get into the solution the lactate of barium. The precipitate formed after a period of 12 hours was separated by the filtration, and the filtrate was evaporated under the reduced pressure to get lactate in a crystalline from. The crystallized lactate was washed several times and was determined as aldehyde after Ripperis method.

Succinic acid. The said barium salts, under lactic acid separation, which have gone to precipitation by 80 % alcohol, comprise succinate, malate and a trace of fumarate. To isolate succinic acid[2] from the contamination, malic acid was decomposed by potassium permanganate of 5% solution, adding drop by drop to a warm solution of the salts, until the red colouration of the reagent stand persistent. Further, to this solution 5 c.c. of the reagent viz. an excess of it was added and after a period of 15 minutes, in a cooled state the excess of the reagent was removed by SO_2, and then acidifying by sulphuric acid the free acid was extracted by ether as done in a common way.

Succinic acid, thus obtained gave melting point of 183°C (uncorrect).

Malic acid. To identify malic acid, barium salts which were insoluble in alcohol of 80 v. % was acidified with sulphuric acid and extracted with ether. From the ether extract the acid was identified after Dakin's[3] method. Cinchonin–*l*–malate thus obtained melted at 199°C.

(2) Refar to R. Kunz's method (1903.)
(3) Dakin ; Journal of Biol, Chem. Vol. LIX, No. 1., p. 7. 1924.

ON THE PHYSIOLOGY OF RHIZOPUS SPECIES. PART IV.

THE RELATION BETWEEN THE CARBON SOURCE AND THE PRODUCTION OF ALCOHOL AND ACIDS, ESPECIALLY THE FORMATION OF SUCCINIC ACID FROM GLYCERINE.

By Teizo TAKAHASHI and Kinichiro SAKAGUCHI.

(Received Feb. 15th., 1927.)

The formation of both alcohol and fumaric acid by Rhizopus species from carbohydrates, such as glucose, saccharose, starch as well as from tartaric[1] and gluconic acids[2] was already confirmed by the systematic way of researches. It was also reported by us the formation of alcohol from fumaric acid by this fungus.[3]

As to the formation of lactic acid[4] by this species not only from carbohydrates such as glucose, sucrose and starch but also from fumaric acid was mentioned in the former report.

As for the formation of succinic acid, by this fungus, in regard to its carbon source, is quite analogous to that of the case of fumaric acid, with only one exception of acetic acid, which contribute as carbon source just for the former acid.

A further research was made on the formation of alcohol and organic acids from other carbon sources than we have already concerned, by this fungus, and the authors were able to find out some unusual or singular instances in the formation of alcohol. The results were that, all carbohydrates tried were suitable for the formation of the alcohol; although a trace was to be found in the cases of such sources as xylose, fructose, lactose or inulin. This is rather a singular phenomenon, since galactose gives a moderate quantity of alcohol and sucrose a rather large quantity of it. The former may nothing more than the absence of an enzyme lactase in fungus, but the latter phenomenon finds its explanation just by the assumption that fructose, at status nascendi, behaves quite different from common fructose; because sucrose gives almost an equal quantity of alcohol as maltose does, or gives rather larger quantity of it than glucose, in as much as the doses of these carbon sources

(1) The Journ of Agric. Chem. Soc. of Japan. Vol. II, No 5, p 63 and 62.
(2) This Same Journal.
(3) Do. Vol. II, No. 5, p. 62.
(4) This Journal.

are equal.

In the medium, containing glycerine as only carbon source, there was no formation of alcohol ; although more or less growth of fungus was to be observable.

Fumari acid. This acid was able to be formed from all carbohydrates used, beside lactose, but from glycerine none of it was formed.

Succinic acid. This acid was found in all culture media, containing carbohydrates we have concerned, except those contributing as carbon source such one like inulin, galactose or xylose.

The formation of succinic acid from glycerine by this fungus is a rather noteworthy fact and its mechanism may be representable by the following way :-

1) $$2\begin{matrix}CH_2\cdot OH\\ |\\ CH\cdot OH\\ |\\ CH_2\cdot OH\end{matrix} = 3\ CH_3\cdot COOH + 2H_2$$ (5)

2) $$2\ CH_3\cdot COOH = \begin{matrix}CH_2\cdot COOH\\ |\\ CH_2\cdot COOH\end{matrix} + H_2$$

If we remind formation of aldehyde in such a case the third equation must comes forth :-

3) $2\ CH_3\cdot COOH = 2\ CH_3\cdot COH + O_2$ Then comes forward :-

Glycerine. Succinic acid. Succinic acid.

Acetic acid. ⇄ Aldehyde. ⇄ Acetic acid ⇄ Aldehyde.

Malic acid. This acid was formed from glucose, fructose, mannose, sucrose, maltose and starch but not from xylose, galactose, lactose, dextrine, inulin or glycerine. Upon the whole, the nature of the formation is almost equal as we have experienced in the case of succinic acid, except lactose, dextrine and glycerine.

Lactic acid. The formation of this acid from various carbon sources by this fungus is quite analogous to that of fumaric acid, except this acid may take lactose as its carbon source, when such a source could not play role for the formation of fumaric acid.

The results are tabulated below :-

(5) Refer to Takahashi and Asai's article "on the formation of acid by Rhiz. sp. part. IV." This Journal.

Carbon Sources.	Starch.	Inulin.	Dextrin.	Sucrose.	Lactose.	Maltose.	Glucose.	Fructose.	Galactose.	Mannose.	Xylose.	Glycerine.
Weight of fungus. (g.)	0.187	0.121	0.264	0.182	0 013	0.179	0.138	0.119	0.145	0.151	0.179	0.080
Alcohol (g.) in 100c c.[6]	0.12	Jod. r. +	0.08	0.20	trace.	0.22	0.15	Trace.	0.10	0.18	Trace.	/
Volatile acid c.c. of $^{n}/_{10}$ NaOH. for 20c.c.	/	0.5	0.4	/	0.1	0.2	/	0.4	0.5	0.6	0.6	0.10
Fumaric acid. m p and etc.	Form. report.	284°C	284°C	Form report.	/	Trace[7]	Form. report.	285°C	284°C[8]	285°C[9]	285°C[10]	/
Succinic acid m p etc.	182–183°C	/	Trace.	183°C	Trace[11] 183°C	183–185°C[12]	Form. report.	Trace.	/	183°C	/	Trace[13] 183°C
Malic acid.	+	–	–	+	–	+?	+	+	–	+	–	–
Lactic acid.	+	+	+	+	+	+	+	+	+	+	+	– ?

Experimental.

The fungus used was Rhizopus G. 34. Yamazaki, and the culture media were prepared in such a way that each 50c.c. of the solution of mineral matters[13], containing 0.125g. of glycebcoll and 1g. of $CaCO_3$ was taken in each time and to this solution any carbon source desired was added in a dose of 5%.

After a period of the culture of 16 days at 28–30°C, acids were determined or detected.

Fumaric acid. To determine this acid, it was derived into its calcium salt and calcium was precipitated as calcium oxalate, which was titrated by $^{n}/_{10}$ potassium-permanganate solution after acidified by hot hydrochloric acid of 5 %. Where, 1c.c. of the reagent of permanganate used corresponds to 0.004g. of calcium or 0.0116g. of fumaric acid.

(6) 1c c of $^{n}/_{10}$ potassium permanganate corresponds to 0.0116g. of fumaric acid.
(7) This substance gave positive reaction of β-naphtol + H_2SO_4 and resorcine + H_2SO_4. (Author's reactions.)
(8) It amounted to 0.15g.
(9) Its amounts were 1.2Cg.
(10) It amounted to 0.10g.
(11) 4.9g. of lactose gave 0.61g. of succin'c acid.
(12) From 8.0g. of glycerine, there was formed 0.105g. of succinic acid.
(13) Mineral matters employed throughout our researches.

Separation of succinic and fumaric acids. In the residue of alcohol determination, the precipitate which formed was collected when hot and after washing with boiling water, was treated by ether to extract succinic acid, provided the acidification of the fluid by H_2SO_4. The other part of succinic acid was isolated from the filtrate from above precipitate, by common means of ether extraction; where fumaric acid comes together with succinic acid. The easy soluble property, in water, of the latter acid affords us very simple way of separation from fumaric acid in the mixture.

Detection of lactic and malic acids. About the ether extract above stated, malic acid was detected by Denige's and author's reaction,[14] and lactic acid by well known Hopkin's reaction or by the formation of iodoform.

(Jan 30. 1927.)

(14) β-Naphtol and H_2SO_4. J. of Agric. Chem. Soc. Jap. Vol. 1, No. 14.

MICROBIOLOGLCAL INVESTIGATION ON THE SOIL AND SEA-WATER FROM OGASAWARA ISLANDS. I.

By Hisamoto NAKAGAWA and Satio ARAKAWA.

(Ohara Institute for Agricultural Research. Kurashiki, Okayama-Ken.)

(Received Oct. 20th., 1926.)

The Ogasawara Islands are interesting from historical as well as biological point of view. The Islands came in the Japanese possession only a half century ago, and inhabited by the descendants of different nationalities. Geologically the Islands are volcanic, and in fact, one of the Islands named Iwojima (Sulfur Island) has sulfur spring and deposit all over the island, and many craters are found. The earth surface is so hot that one can hardly walk barefooted. Geographically the Islands are located far south of the Tokyo Bay in the Pacific, almost in a tropical zone having the mean temperature of 22.4°C throughout a year. Consequently it was anticipated that there may be some interesting findings among the flora of microorganisms, and one of the authors visited the Islands at the begining of this year and brought back the samples about which this report is concerned.

The samples of soil were taken from seven localities and three samples

of sea-water, as indicated on the map, and the quantitative and morphological examination of microorganisms together with the determination of hydrogen ion concentration were made, and the following results were obtained:

1. PH values of the soil samples lie between 5.26 to 7.68. It is noteworthy that the soil E which was taken near the crater showed the highest hydrogen ion concentration.

2. PH values of the sea-water lie between 7.32 to 7.64 which are about the same with those values found elsewhere.

3. The quantitative determination of microorganisms indicated the presence of 9,000–701,600 on the nutrient agar plates; 524,600–7,415,800 on soil extract agar. Besides these culture medium, Ashby agar medium was used and found some organisms which made good growth.

4. All the organisms isolated were Gram positive. It was observed that many of those came from the soil were rod shaped while mostly coccic, from the sea-water.

The further report on this investigation will appear in future.

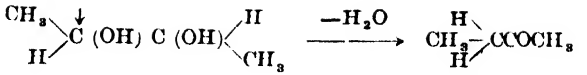
ON THE PINACOLINE TRANSFORMATION OF 2. 3–BUTYLENEGLYCOL AND ITS IDENTIFICATION.

By Tomotsune TAIRA.

(Received March. 2nd., 1927.)

That α-glycol, on boiling with dilute sulphuric acid, yields ketone by splitting one molecule of water and an alkyl group migrating to the neighboring carbon atom, is generally known under the name of pinacoline transformation of the same.

This reaction was first obserbed by Butlerow (A. 170 162 (1872)) on pinacone, followed by many authors on compound of more or less complex build, but hitherto no mention is made in the literature about the transformation of 2. 3-butyleneglycol. The author (This Journ. **25**, 734, 1926), in the course of his investigations on the occurence of 2. 3-butyleneglycol in Japanese fermentation products, happened to observe that methyl-ethyl-ketone always accompanied 2. 3-butyleneglycol on distilling such products with dilute sulfuric acid. This ketone must have been produced according to the following scheme and might be regarded as a simple example of the pinacoline transformation.



2. 3-butyleneglycol methyl-ethyl-ketone

Since methyl-ethy-ketone can readily be estimated as its *p*-nitrophenyl-hydrazone, 2. 3-butyleneglycol can also be identified by preparing the same.

Experimental.

Preparation of 2. 3-butyleneglycol.

2. 3-butyleneglycol was extracted from soya-sauce and saké in the following way.

A quantity of saké (or soya-sauce) was evaporated to a syrupy consistency under diminished pressures and it was then extracted with ether after being made slightly alkaline with caustic soda solution. The ethereal extract was dried, ether driven off by distillation and the residue thus obtained was subjected to the fractional distillation in vacuo, when a glycerine like substance having the characteristic odour of those fermentation products came over at 70–80°C under a pressure of 5–6m.m. mercury. After being rectified by repeated vacuum distillations, the substance distilled almost constantly at 170–180°C under normal pressure, with a density 1.004 and n_D^{20} 1.4300.

0.1104 g of substance gave 0.2151 g CO_2 and 0.1048 g. H_2O
0.2754 g. of substance gave 0.5334 g. CO_2 and 0.2496 g H_2O

	C 53.13 %	H 10.54 %
	C 52.83 %	H 10.07 %
$C_4H_{10}O_2$ requires	C 53.33 %	H 11.11 %

The molecular weight determined by the freezing point method using glacial acetic acid gave the following results.

substance (g.)	solvent (g.)	depression of freezing point	molecular weight
0.2240	21.2900	0.198	
		0.526	
		0.520	
		mean 0.515	79

The same by the elevation of boiling point using methyl alcohol was,

substance (g.)	solvent (g.)	ebullition of boiling point	molecular weight
0.2600	15.277	0.180	80
	Calculated from	$C_4H_{10}O_2$	90

Preparation of diphenylurethane.

The mixture of 1c.c. of the substance with 2c.c. of phenylisocyanate and 5c.c. of benzene was warmed on the flame, and on standing, the formation of needle crystals was obserbed, which after due purification melted

at 200° and was proved to be the diphenylurethane of 2, 3-butyleneglycol.

Oxidation to diacetyl by bromine in presence of ferric chloride.

0.5g. of the substance together with 2c.c. of bromine, 0.3g. of ferric chloride and 5g. of sodium acetate were heated on the water bath for 20 minutes, the excess of bromine was removed with sodium bisulfite sotution and then the residue was distilled on the oil bath. The distillate represented a floating oily substance having a very pungent odour. One drop of the distillate taken in a test tube and 1c.c. of 20 % hydroxylamine hydrochloride solution and 2c.c. of 20 % sodium acetate solution were added. After little boiling, it gave a apecial carmine coloured needle like crystal of nickel-dimethylglyoxime on adding a few drops of 10% nickel chloride solution(Kluyver and his coworker ; Biochem. Zts. 161 361 (1926)). To the residue of the above test water solution of hydroxylamine hydrochloride was added and neutralized with sodium carbonate. On standing some time white crystal were obtained, which was filtered and washed with water and dried in a desiccator. The crystal showed a melting point of 234°–235°C and found to be the diacetyldioxime related by Wolff (A 288 27). Dehydration with 25% sulphuric acid.

0.5g. of the substance was taken in a distillation flask, added 30c.c. of 25% sulphuric acid and distilled on the oil bath until the thermometer of the bath indicates 130°C. The distillate was cooled by the freezing mixture and 20c.c. of aldehyde like odoured liquid was obtained. On mixing the distillate with 1/2 volume of acetic acid and 30 % acetic acid solution of *p*-nitrophenylhydrazine, yellow needle crystals soon appeared, which was filtered and washed with 39% acetic acid and recrystallized from 40% ethyl alcohol. The melting point of it was 130°C.

Analysis 0.0825 g. of the substance gave 15.4c.c. N (31°C 755 m.m.)

Found	20.29%
Calculated from $C_{10}H_{13}N_3O_2$	20.18%

The above results closely ressmble to isobutylaldehyde-*p*-nitrophenyl-hydrazone $(CH_3)_2$ CHCH : $NNHC_6H_4NO_2$ (m. p. 130°–132°C) and also to its isomeric methyl-ethyl-ketone-*p*-nitrophenylhydrazone CH_3CH_2C: NNH $C_6H_4NO_2$ CH_3 (m. p. 128–129°C). When the substance mixed with the former, they showed a melting point of 103°C, and with the latter, they showed no tendency of depressing the melting point.

Summary.

1. Observed the pinacoline transformation of 2. 3-butyleneglycol.
2. 2. 3-butyleneglycol can be identified by the dehydration with 25% sulphuric acid, namely by the formation of methyl-ethyl-ketone-*p*-nitrophenylhydrazone.

(Government Research Institute. Formosa.)

DIGESTION AND METABOLISM EXPERIMENTS WITH SHEEP FED ON MIXED HAY.

By Michio Saitoh.

(From the laboratory of animal nutrition in Miyazaki College of Agriculture.)

(Received Feb. 5th., 1927.)

Two mature Shropshire sheep of nearly the same age were selected and fed almost half a year on mixed hay as maintenance ration. About thousand kilogrammes of hay were gathered from the uncultivated land, cut 1–2 inches long and mixed thoroughly in order to feed the same quality of hay during experiment. The sheep maintained their body weight every day with certain quantities of this fodder. In the middle period of this experiment, feces and urines excreted by the animals were taken and analyzed.

Detail analytical data of the hay used were already published in Japanese Journal of Zootechnical Science Vol. I. No. 2.

The experimental results here obtained are as follows:

1. Digestibilities of general constituents of this hay do not differ from the results obtained by former investigators. Average digestibilities are:

62 % of dry matter	67 % of organic matter
48 % of crude protein	56 % of crude fat
71 % of carbohydrates	27 % of crude ashes

2. Nitrogen distribution of feces are determined:

Water soluble nitrogen	25 %
Water soluble protein nitrogen	7 %
Nitrogen soluble in 10 % salt solution	7 %
Nitrogen soluble in 75 % alcohol	5 %
Nitrogen soluble in dilute alkali	33 %
Insoluble nitrogen	30 %

3. In carbohydrates of feces, following compounds were determined:

Total carbohydrates in dried feces 48–49%

In hundred percent of total carbohydrates:

Weende's crude fiber	35 %
Cellulose	18–19 %
Cutin	7–9 %
Lignin	7 %
Pentosan	21–24 %
Pentosan-free nitrogen-free extract	45–49 %
Starch and soluble sugars	4 %

4. Feces contained following mineral compounds:

Total crude ashes in dried feces 21–23%

In hundred percent of total ashes:

Potash	2–3 %
Soda	4 %
Lime	8–10 %
Magnesia	4 %
Iron oxide	6–7 %
Phosphoric acid	7–8 %
Chlorine	0.1 %
Sulfuric acid	2 %
Silicic acid and sands	64–67 %

5. As to urines following results were obtained:

Reaction, strongly alkaline

Specific gravity 1.034–1.0571

Dry matter in urine 3.9–6.8

In hundred percent of urinary dry matter:

Organic matter	48 %
Inorganic matter	52 %
Urea	9–15 %
Ammonia (Immediately)	0.2–0.5 %
Hippuric acid	29–38 %
Uric acid	0.3–0.9 %
Creatinin	0 1 %
Other organic matters	2 %

6. In hundred percent of urinary ashes were found following substances:

Potash	56–60 %
Soda	5–6 %
Lime	0.6–0.4 %
Magnesia	3–5 %
Iron oxide	0.4–0.8 %
Phosphoric acid	0.3–0.4 %
Chlorine	24–27 %
Sulfuric acid	7–9 %
Silicic acid	1–4 %

7. Apparent digestibilities were calculated (Average of two sheep):

Weende's crude fiber	72 %
Weende's nitrogen-free extract	70 %
Cellulose	78 %
Cutin	67 %
Lignin	59 %
Pentosan	72 %
Pentosan free nitrogen extract	68 %

8. After investigation upon nitrogen metabolism, each sheep was found to have digested 7–8 grammes of nitrogen and deposited 2.8–2.9 grammes of nitrogen every day. Sheep excreted every day 12–17 grammes of hippuric

acid i. e. sheep produced every day 3.8-6.5 grammes of glycocoll and 8.8-13.0 grammes of benzoic acid in the body, according to the following formula:

$$C_6H_5CONH\cdot CH_2\cdot COOH \xrightarrow{H_2O} C_6H_5COOH + CH_2(NH_2)\cdot COOH$$

while they digested only 40 grammes of crude protein. Therefore author has thought that the production of hippuric acid in animal body should be attributed in greater part, to the carbohydrates of food taken and glycocoll contained in hippuric acid should not only be produced from food glycocoll but also changed from other amino acid of food protein.

9. Calculation of apparent digestibilities of hay ashes showed that:

Chlorine	was digested	98 %
Potash	〃 〃	86 %
Sulfuric acid	〃 〃	66 %
while,		
Soda	was digested	only 20 %
Lime	〃 〃	〃 12 %
Magnesia	〃 〃	〃 15 %
Iron oxide	〃 〃	〃 18 %
Phosphoric acid	〃 〃	〃 15 %

10. Each sheep showed positive balance of every mineral matters except soda and magnesia, and one sheep showed negative balance of chlorine. The mixed hay used was contained too much of potash compared to soda and a little exess of lime compared to magnesia. It also cantained much of silicic acid. Therefore if sheep are to be fed on hay alone, it will be advisable to give additional amounts of salts containing small amount of magnesia (impure salts).

11. Finally, the author calculated the proportion of hay ashes distributed in urines, feces and balances. Potash was excreted 80–88% in urine and only 11–16% in feces, while soda was excreted only 25–29% in urine and 80% in feces. Lime was excreted almost completely in feces. Magnesia was also excreted largely in feces but it was excreted 18–28% in urine. Both phosphoric acid and iron oxide were excreted almost completely in feces. On the other hand, chlorine was excreted completely in urine. Sulfur was excreted equally in urine and in feces.

ON THE APPLICTION OF THE POLAROGRAPH TO THE ANALYSIS OF ABNORMAL MINERAL CONSTITUENTS.

By Masuzo Shikata, Isamu Tachi and Nobushige Hozaki

(*Agricultural Chemical Laboratory, Faculty of Agriculture, Kyoto Imperial University.*)

(Received Mar. 10th, 1927).

The applicability of the mercury dropping cathode and the Polarograph to the microanalysis of metallic ions has been suggested by Prof. Heyrovsky and his colaborators. The present authors has tried to show to what extent this method can be applied to the biochemical problems.

Prof. Ikutaro Hirai has proved the menigitis-like disease of the infants, often seen in Japan, must be caused by the lead poisonning. This is shown by the presence of lead in brain, lung, heart, epiphragma, milt, gaster, intestine, liver, bone, hairs, urin and feces. However, the present authors have been told that no lead has been detected in 20 to 30ccm. of the cerebrospinal fluid of the patients.

The cerebrospinal fluids analysed in our experiments were 20 to 50ccm. taken from the patients, and have been forwarded by Prof. Hirai after he has evaporated and ignited the fluids under 500°C.

This ash has been extracted with 25ccm. of 1 n NaOH and electrolysed with the polarograph.

By the "polarogram" thus taken, the lead has been detected by the wave of the current voltage curve.

Among 9 samples, 0.006mg. to 0.015mg. Pb has been detected in 6 samples, and its trace in one sample, while no lead has been proved in two other sample.

As the second example, the Cu in the canned green peas has been determined. Cu is used as the colouring stuff to the green peas, fixing chlorophyll as copper phyllocyanate.

In this case 0.135mg. of Cu has been found in 2.319g. of green peas, i. e. 58.3mg. in Kg sample.

The limit of the concentration of Cu, which can be detected by the polarograph with the galvanometer of 10^{-8} amp. is 0.02mg. in 50ccm. i. e. 10^{-5} normal solution.

So it is quite easy to determine copper when we take 2g. of green peas.

This result has been compared by the ordinary electroanalysis by taking

40.3g. of green peas and it has been found that 1.7mg. copper in the sample, i. e. 37.13mg. per Kg sample.

This difference suggested us, that there must have been some loss of copper in the electrolysing solution. The residual solution after electrolysis, has been tested with the polarograph.

The polarogram showed that there was 0.7mg. Cu remaining in the solution, i. e. 15.29mg. per Kg sample.

Thus the sum of these two results is 52.42mg. So the electroanalysis, when corrected the loss of Cu in the solution after electrolysis is in fair accord with the polarographic measurements, i. e. discrepancy of about 10%.

From these two examples the applications of polarograph to the micro-analysis of abnormal inorganic constituents are shown to the satisfactory extent.

RESEARCH ON REDUCTION POTENTIALS OF ORGANIC COMPOUNDS. (Part II.)

REDUCTION POTENTIAL OF PYRIDINE.

By Masuzo Shikata and Isamu Tachi.

(*Agricultural Chemical Laboratory, Faculty of Agriculture, Kyoto Imperial University.*)

(Received Mar. 10th, 1927.)

Summary.

(1) Reduction potential of pyridine has been measured with the dropping mercury cathode and the "Polarograph".

(2) Reduction potential of pyridine has been followed in acidic, neutral and alkaline solution.

(3) Reduction of pyridine proceeds in some way similar to the reversible reduction. However, reduction potentials, when compared with those, calculated by the Nernst formula, show much greater deviations than in the cases of reversible reductions such as isovaleraldehyde and nitrobenzene.

(4) Two waves of reduction have been observed in an acidic and in a neutral solution, the first wave is proved to be the reduction of pyridine ion, and the second to be that of undissociated molecule of pyridine.

Such a distinction could not have been established by the ordinary electrolytic measurement of oxydation-reduction system.

ON THE EGG-YOLK OIL.

By Kôzô Suzuki.

(*From the Chemical Laboratory of Imperial Zootechnical Experiment Station, Chiba.*)

(Received Mar. 21st., 1927.)

Having made a comparative study on the general properties and the kinds of fatty acids of the yolk of the eggs, which were producted by two different breeds, single comb White Leghorn and Chinese hens, the writer obtained the following results.

Egg-yolk oil has a special rank odour resembling that of cod liver oil and its colour is brownish yellow.

At the ordinal temperature, it is a liquid containing many fine needle formed crystallines, but it almost solidifies in winter.

General properties.

	White Leghorn	Chinese hens
Special Gravity (at 16°C)	0.9767	0.9787
Refractive Index	1.4565	1.4690
Acid Value	8.82	10.43
Reichert-Meissl Value	0 88	0.88
Saponification Value	192.3	196.0
Iodine Value	70.7	70.1
Unsaponifiable Matter (%)	8.46	13.90

Properties of mixed fatty acids.

Solidifying Point	35 8°C.	34.0°C.
Melting Point	39°-42°C.	38°-39.5°C.
Neutralization Value	191.88	202.50
Mean Molecular Weight	292.37	277.01
Specific Gravity (at 15°C.)	0.9576	0.9581
Iodine Value	80.63	73.64
Amount of Saturated Fatty Acids (%)	30.41	32.15
Amount of Unsaturated fatty acids (%)	69.59	67.85

Properties of mixed saturated fatty acids.

Melting Point	54°-57°C.	51°-55°C.
Solidifying Point	53°C.	49°C.
Neutralization Value	211.6	219.7
Mean Molecular Weight	265.12	255.34

Properties of Mixed Unsaturated fatty acids.

Specific Gravity (at 15°C.)	0.9679	0.9665
Iodine Value	91.16	94.97
Neutralization Value	163.2	192.5
Mean Molecular Weight	290.37	291.43

About 2/3 of the total amount of the saturated fatty acids is isopalmitic acid (m. p. 57°C.) and 1/3 is palmitic acid (m. p. 62°C.).

Stearic acid is found to contain in the yolk oil of the eggs of White Leghorn but its amount is only 4 percent of saturated fatty acids.

Unsaturated fatty acids consist of the great amount of oleic acid and a very small quantity of linolic acid.

There exists also a very small amount of arachdonic acid in the yolk oil of Chinese eggs.

This difference regarding the constituents of the egg-yolk oil may be due to the kinds of feed, with which hens are fed, and not due to the difference of species.

ON THE DISTRIBUTION OF ACETYLMETHLCARBINOL AND 2, 3-BUTYLENE GLYCOL IN JAPANESE FERMENTATION PRODUCTS.

By Yukio Tomiyasu.

(From the Agricultural Chemical Laboratory, Department of Agriculture, Kyushu Imperial University, Fukuoka.)

(Received Apr. 10th., 1927.)

Since the production of acetylmethylcarbinol and 2, 3-butylene glycol by various microorganisms has often been reported by many investigators, the author supposed a wide distribution of these substances in fermentation products, and surveyed them by the modified method of Lemoigne. The results were summarized as follows :-

1. The occurrence of acetoin and 2, 3-butylene glycol was detected in various fermented vinegars. The acetoin-content of rice-vinegar was so larger than that of spirit-vinegar, that the sort of the vinegar could easily be differentiated by estimating the amount of acetoin. The spirit-vinegar, moreover, does not contain any 2, 3-butylene glycol, so that they could be distinguished clearly through its existence.

2. These substances were also found in saké. Their production seems to be mainly due to the action of saké-yeasts and probably not to the lactic acid bacteria. Attempting to distinguish the diseased saké or "Hiochi" from the sound by the estimation of the acetoin and 2, 3-butylene glycol-content,

the author found that their amount was generally richer in the diseased saké than in the sound. The attempt to distinguish them, therefore, resulted in vain. This result shows that some of the "Hiochi" bacteria produces them.

3. The author detected the existence of them in soy and strawberry-wine, while 2, 3-butylene glycol was proved alone in beer, wine, and "Miso", which is a very common food made from soy beans, rice or barley, common salt, and water.

4. Acetoin combines with sulphite as well as aldehyde, (Neuberg ; Biochem. Zeitschr. **140**, 299, 1923), so that when the Ripper's method being applied for estimating aldehyde in the fermentation products which contain acetoin, it must be taken care upon this fact.

In conclusion the author wishes to express his thanks to Prof. Dr. M. Yukawa, Prof. Dr. Y. Okuda, and Ass. Prof. I. Yamasaki for their kind direction and advice throughout the investigation.

ON THE WEATHERING OF THE GRANITE-ROCKS OF TWO DISTRICTS IN JAPAN.

By Shigeru Osugi and Takeo Tanaka.

(Dept. of Agr. Kyoto Imp. Univ.)

(Received Apr. 11th., 1927.)

1. The weathering of the granite-rocks collected in Kyoto and Kagawa Prefectures in Japan, was investigated.

The climatic conditions of the districts noted above are as follows:

District	Annual temperature (°C)			Annual rain-fall (m m.)
	Max.	Min.	Ave	
Shirakawa, Kyoto, Japan	19.94	8 45	13.76	1587 58
Kida mura, Kagawa, Shikoku, Japan.	19 50	10 50	16 60	1185.60

2. The composition of the fresh rock and the weathered products of various stages was determined.

The calculation on the loss and the gain of each constituent during the weathering process, was made after Merrill's method.

The results thus obtained, were compared with those reported by Merrill, as shown in the following table;

District.		% loss of each constituent.														% total loss to entire rock	
		SiO_2		Al_2O_3		Fe_2O_3		CaO		MgO		Na_2O		K_2O			
			b	a	b	a	b	a	b	a	b	a	b	a	b	a	b
Shirakawa, Kyoto, Japan.	B	5.68	23.29	0	13.29	15.35 gain	0	39.13	47.23	28.32	46.53	47.28	54.29	41.61	49.37	15.37	26.50
	C	5.37	17.76	0	7.38	7.38 gain	0	41.58	45.16	56.55	59.74	71.79	73.86	68.61	70.91	18.41	23.74
	D	1.50	16.87	0	10.03	11.66 gain	0	53.66	58.32	54.49	59.06	70.18	73 17	60.25	64.24	16.06	23.51
Kida-mura, Kagawa, Japan.	B	25 20	2.82	0	29.85 gain	25.30	0	35.00	15.60	27.20	5.42	68.40	58.97	39.80	21.78	25.19	0.78
	C	7.81	23.27	0	15.86	18.80 gain	0	39.10	48.79	27.70	39.15	64.50	70.14	26.40	38.07	10.56	24.02
	D	5.23	21.59	0	17.22	20.79	0	55.30	63.01	35 90	46.94	78.10	81 89	18.10	32.16	8.00	23.57
District of Columbia, U.S.A.(1)		—	14.89	—	3.23	—	0	—	25.21	—	14.90	—	28.62	—	31.98	—	13.78
Virginia U.S.A.(2)		—	52.45	—	14.39	—	0	—	100	—	74.70	—	45.03	—	83.52	—	44.67
Georgia, U.S.A.(3)		—	77.20	—	43.82	—	0	—	98.78	—	87.94	—	92.16	—	91 75	—	71.84

Remarks:

a..... ...Calculated on assumption that alumina has not been lost at all.

b..... " " " ferric oxide " "

B.....First stage. (weathered rock block) C.....Second stage. D. ...Residual soil.

(1)... ...Example of the disintegration of granite. (Residual soil only)

(2)..... Example of the chemical weathering of granite. (Residnal soil only)

From the above table, it may be assumed that the predominating factor of the changes taking place in the rocks under investigation, is rather physical than chemical nature although the latter is not ignored.

3. The change of the mineral composition was then investigated and the results obtained are noted in the following table.

The table shows that even feldspar and biotite which are supposed to be rather easily decomposed chemically, were not changed to any extent.

Only in case of the biotite, a distinct loss is recognized although the loss is not so marked as to be expected from the chemical weathering.

	Kyoto, Japan(1)			Kagawa, Japan(1)		
	Quartz.	Feldspar.	Biotite.	Quartz	Feldspar.	Biotite.
A	1	0.63	0.42	1	0.49	0.31
B	1	0.61	0.27	1	0.64	0.36
C	1	0.79	0.35	1	0.40	0.34
D	1	0.97	0.26	1	0.59	0.09

[(1) In this table, only the ratio of mineral is shown.]
A..... fresh rock. B ....first weathering product.
C..... second weathering product. D .... residual soil.

4. The mechanical composition of the weathered products was tested, and obtained the following results which indicate that the products are mainly consisted of coarser particles such as the gravels and the coarse sands, and only a very small quantity of clay is found in the products.

	Kyoto, Japan.		Kagawa, Japan.		District of Columbia. U.S.A.	
	gravel and coarse sand.	fine sand and silt.	gravel and coarse sand.	fine sand and silt.	gravel and coarse sand.	fine(1) sand and silt.
B(2)	85.00%	14.00%	95.43%	4.57%	—	—
C	83.05	14.57	84.26	16 23	—	—
D	61.70	30.39	82.57	17.86	78.00	22.00

(1) Example of the disintegration of granite.
(2) B is powdered mechanically.

The above results show again that the granites named above were changed mainly physically and not much chemical change took place.

5. From the results obtained in three foregoing investigations, it may be concluded that the predominating change taken place in the weathering process of two granites tested, is chiefly physical although the chemical change is considered at the same time.

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STUDIES ON THE ACIDS FORMED BY RHIZOPUS SPECIES. PART V.

By Teizo Takahashi and Kinichiro Sakaguchi.

(Received Apr. 18th., 1927.)

In the first report,[1] authors have stated the occurrence of malic acid in organic acids formed by Rhizopus species, by the tests rather specific to the acid, and later it was isolated and accurately identified by Dakin's method.[2]

Since then, the formation of malic acid by this fungus was affirmed not only from glucose, saccharose, starch or the like, as a cleavage product, but also from some simple compound such as fumaric acid as a synthetic product, in very similar way as formation of succinic acid from acetic acid thus.

Rhiz G. 34, Fumaric acid. 2g. *l*-malic acid. 0.101g.
and 0.132g. as cinchonin malate.

The formation of fumaric–, lactic acid and some volatile acid and ethyl alcohol by this fungus was proved to be the normal products from glucose or other carbohydrates but these also comes to met with when malic acid is given as a carbon source, as is shown in the following table.

Fungus species.	Temp.	Duration of Calture.	Fungus growth(g.) dry m.	Volatile acid. $N/_{10}$ NaOH. to 10c c. medium.	Fumaric acid(g.).	Lactic acid.	Ethyl alcohol W. %	Malic acid. remained. (g.)
Rhiz. G. 36.	21–32°C.	72	0.354	0.5	0.125	+	0.16	+
Rhiz G. 36.	25–30°C.	45	0.310	0.6	0.24	0 09g. as Ba. salt.	+	0.671
Rhiz. G. 34.	21–32°C.	72	0.725	0.5	0.06	±	0.11	+
Rhiz. G. 34.	25–30°C.	45	0.281	1.0	0.43	±	+	0.503

(1) Journ. of The Agric. Chem. Society of Japan. Vol. I. No. 5.
(2) Journ. of The Agric Chem. Society of Japan. Vol. II. No. 5.

Hence, the mechanism of the formation of fumaric-, lactic acid and ethyl alcohol from malic acid may be represented most probably in accordance with following equations :-

a) $2\begin{matrix}CH\cdot OH\cdot COOH\\ |\\ CH_2\cdot COOH\end{matrix} = 2\begin{matrix}CH_2\cdot COOH\\ |\\ CH_2\cdot COOH\end{matrix} + O_2$

b) $\begin{matrix}CH_2\cdot COOH\\ |\\ CH_2\cdot COOH\end{matrix} = \begin{matrix}CH\cdot COOH\\ \|\\ CH\cdot COOH\end{matrix} + H_2$

c) $\begin{matrix}CH\cdot COOH\\ \|\\ CH\cdot COOH\end{matrix} + \begin{matrix}H\\ |\\ OH\end{matrix} = \begin{matrix}CH_3\\ |\\ CH\cdot OH\\ |\\ COOH\end{matrix} + CO_2$

d) $\begin{matrix}CH_3\\ |\\ CH\cdot OH\\ |\\ COOH\end{matrix} = \begin{matrix}CH_3\\ |\\ CO\\ |\\ COOH\end{matrix} + H_2$

e) $\begin{matrix}CH_3\\ |\\ CO\\ |\\ COOH\end{matrix} = CH_3\cdot COH + CO_2$

f) $CH_3\cdot COH + H_2 = CH_3\cdot CH_2\ OH$

The first equation viz., the occurrence of succinic acid in the products was not affirmed by this chance, but it is most probable to assume the acid as an intermediate product, as we have already stated, when gluconic acid is given as only carbon source of the culture medium.

The quantity of ethyl alcohol found was too small to be mentioned. This is nothing but that we have limitted or rather minimamized the quantity of nitrogen source of nutrient viz., the most unfabourable condition for the nomal evolution of alcohol.

The synthetic formation of malic acid from fumaric acid is most simple and the nature of the change which ensue may not be other than the following representation :

$$\begin{matrix}CH\cdot COOH\\ \|\\ CH\cdot COOH\end{matrix} + \begin{matrix}OH\\ |\\ H\end{matrix} = \begin{matrix}CH\ OH\cdot COOH\\ |\\ CH_2\cdot COOH\end{matrix}$$

From these facts, it seems to us that fungus aught just to get nothing else but the energy for its growth, irrespective whether synthesis or decomposition of the substances is going on in the medium.

Experimental.

I) The formation of fumaric acid and other substances from malic acid. The culture medium constituted of; distilled water 150c.c., malic acid*

* Pure material from Märck's brand.

3g., 10% NH_4OH. 15c.c., $CaCO_3$ 4g., K_2HPO_4 and KH_2PO_4 each 0.0225g., $CaCl_2$ and $MgSO_4$ each 0.015g., NaCl and Fe_2Cl_6 each trace.

Volatile acid was determined with the distillate of steam destillation of 10c.c. of the culture medium.

Fumaric acid was isolated from 150c.c. of the culture medium by the extraction by ether, as already stated several times, after the removal of alcohol by distillation, as shown below :–

	From Rhiz. G. 36.	From Rhiz. G. 34.	Calcul.
Melting point.	281-284°C.	280–284°C.	—
Number of titration (0.1g.)	17.2c.c. $^N/_{10}$NaOH	17.2c c. $^N/_{10}$NaOH	17.24c.c.
Silver salt.	0.0817g.	0.0691g.	—
AgCl.	0.0709g.	0.0059g.	—
Ag.	65.30%	65.25%	65.44%

Malic acid, unassimilated, was isolated from soluble part of ether extract stated as above, by the nutralizing with baryta water followed by the addition of 80% of alcohol, which dissolving lactate and remaining behind malate as a precipitate.

Lactic acid. Qualitative tests were made about barium salt, which comes in solution in 80% alcohol as mentioned above, after Hapkin's Denige's[3] and authors[4] reactions.

Aldehyde was detected in the neutral distillate by Schiff's reaction and Na–nitroprussid and aqueous alkali.

II) The formation of *l*–malic acid from fumaric acid.

The culture medium used was :– Fumaric acid 2g., $(NH_4)_2SO_4$ 0.5g., $CaCO_3$ 3g., K_2HPO_4 and KH_2PO_4 each 0.015g., $CaCl_2$ and $MgSO_4$ each 0.01g., NaCl and Fe_2Cl_6 each trace, distilled water 100c.c.

The duration of the culture was 42 days at room temperature.

l–Malic acid :– To isolate the acid the culture medium was extracted, as stated several times, with ether and from this extract the soluble part in water was separated from unaltered fumaric acid, and from aqueous solution hygroscopic crystalls appeared after recrystallization from water. This crystalls gave a heavy white precipitate by Denige's reagent and reduced palladium chloride. Its melting point was 99–100°C, which is accurately

(3) Guajacol and H_2SO_4 (Denige'. Zeit. f. Anal. Chem. 50. 1911, 189).
(4) β-Naphtol and H_2SO_4 (Journ. of Agric. Chem. Soc. Japan. Vol. I. No. 14)
(5) Dakin. Journ. Biol. Chem. Vol. LIX. No. 1. p. 7. 1924.
(6) Pasteur. A., 82, 331, He gave 100°C.

same as that of given by Dakin or Pasteur. Cinchonin-malate prepared after Dakin's method melted at 198–199°C.

The enhanced rotatory power was determined by adding uranium acetate with the results as shown below :–

Substance 0 335%
Temperature 23°C
$\alpha = -1\ 47$ $l = 1$cm.

$$\therefore \quad [\alpha]_D^{23} = \frac{-1\ 47 \times 100}{0\ 335 \times 1} = -438\ 8°$$

For the comparision, Yoder's[7] and Dakin's[8] data should be quoted below :–

After Yoder, C = 1%
$[\alpha]_D^{20} = -501°$
After Dakin, C = 0.5673, $l = 2.2$
$\alpha = -6.02°$
$[\alpha]_D^{18} = -482°$

(7) Yoder · Zeit, f Nahr u Genuss, 22. (1911), 329.
(8) Dakin: ibid.

HYDROGENATION OF STEROL-FREE UNSAPONIFIABLE MATTERS OF COD-LIVER OIL. I.

By Ziro Nakamiya and Kozo Kawakami.

(From the Institute of Physical and Chemical Researches, Tokio.)

(Received May 28th, 1927)

The authors had reported with Dr. Katsumi Takahashi on the physical and chemical properties of Biosterin (a name given to Fat-soluble A) in the Bulletin and the Scientific Papers of their Institute.* A further study has been continued by the present authors on the hydrogenated products of crude Biosterin. They have investigated independently and compared their results in order to ascert ain their experiments.

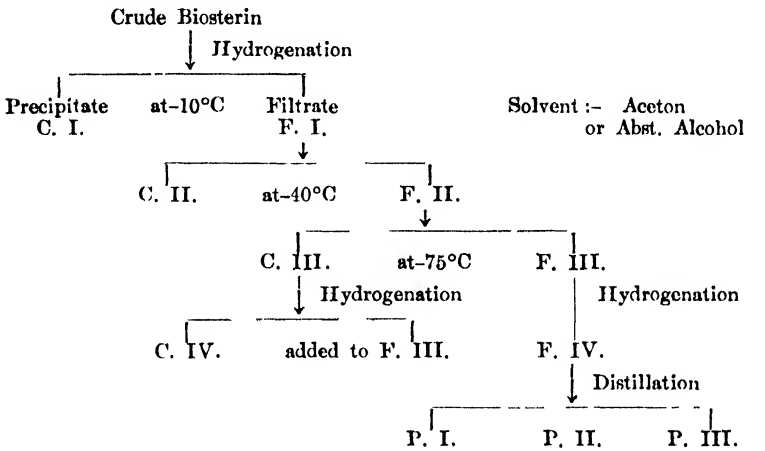
The conclusion was as follows :–

* K. Takahashi, Z. Nakamiya, K. Kawakami, & T. Kitasato :–
Bulletin of the Inst. of Phys. & Chem. Researches. Vol. 3, (1924) No. 6.
K. Takahashi, Z Nakamiya, K. Kawakami, & T. Kitasato :–
Scientific Papers of the Inst. No. 32 (1925).

1. On hydrogenation of crude Biosterin, some of it changed into a crystalline mass, from which the following substances were separated.

Method of hydrogenation :– By Fokin and Willstäter.
Catalyser :– Palladium black, by Tausz and Putnoky's method.

	Nakamiya	Kawakami
Solvent :–	Glacial acetic acid	Acetic ether
Temperature of reaction	60°C	Room temperature



The following two were found in both (N. & K.'s) samples.

Nonacosane $C_{29}H_{60}$

m. p. a) 61.5–62°C b) 62–63°C by N. c) 62°C by K.
Analysis (Micro.) :–

			C%	H%
	Sample a)			
(1)	0.003026g.	Found	85.29	15.12
(2)	0.003220g.		85.20	14.78
		Average	85.25	14.95
	Sample b)			
(1)	0.002910g.	Found	85.22	15.05
(2)	0.003240g.		85.27	15.15
		Average	85.25	15.10
$C_{29}H_{60}$		Calc.	85.30	14.70

(m. p. 62–63°C)

Molecular weight (By Rast's Camphor Method)

Found	428.4	382.2
Calculated	408.0	

Batyl alcohol $C_{21}H_{44}O_3$

m. p. a) 58°C b) 56–57°C by N. c) 62°C by K.
Analysis (Submicro.) :–

			C%	H%	C%
	Sample a)				
(1)	0.0434g.	Found	72.77	12.06	15.17
	Sample b)	(Micro.)			
(2)	0.003160g.		73.19	13.19	13.80
(3)	0 003170g.		72.91	12.51	14.58
	Sample c)				
(1)	0.1094g.		73.24	12.88	13.88
(2)	0.1165g.		73.69	12.95	13.36
	$C_{21}H_{44}O_3$ (m. p. 70–71°C)				
	Calculated		73.18	12.88	13.94

Melting point of the author's samples is yet lower than that of batyl alcohol by Dr. Toyama. The following substances were found in N's samples.

Octadecyl alcohol palmitic acid ester

m. p. 58–59°C

Analysis (micro) :–

	Sample		C%	H%	O%
(1)	0.002925g.	Found	80.14	13.20	6.66
(2)	0,002970g.		80.21	13.41	0.38
		Average	80.18	13 31	6.51

	m. p.	mol. w.	C%	H%	O%
Octadecyl alcohol	59°	270.00	79.91	14.17	5.92
" palmitic acid ester	59°	508.52	80.3	13.1	6 3

Molecular weight (By Rast's method)

527.9 • 518 8

Myricyl alcohol (Melissyl alcohol) $C_{30}H_{61}OH$

m. p. 84°C

Analysis (Micro.) :–

	Sample		C%	H%	O%
(1)	0.003080g.	Found	81.91	14.01	4.08
(2)	0.003070g.		82.26	14.16	3.58
		Average	82.09	14.09	3.82
	$C_{30}H_{61}OH$ (m. p. 85°, or 88°)				
	($C_{31}H_{63}OH$)	Calc.	82.21	14.25	3.54

Molecular weight (By Rast's method)

Found	449.4
Calc.	452.51

Unknown saturated alcohol

m. p. 89-91°C

Analysis (Micro.) :–

Sample		C%	H%	C%
(1) 0.003060g.	Found	79.95	13.90	6.15
(2) 0.003145g.		80.08	13.43	6.49
	Average	80.02	13.67	6.32

Molecular weight (By Rast's method)

Found 454.3 511.1

$C_{34}H_{68}O_2$ (=508) ? C 80.3%, H 13.4%, C 6.3%.

All of these were not always found in each sample used, even after repeated experiments. These results were obtained from many samples during 1925–1927.

Before treatment the original unsaturated compounds in the crude Biosterin may perhaps exist in liquid form, but the authors cannot yet succeed to separate these compounds from Biosterin, for their solubility and boiling point hardly can be distinguished from those of Biosterin.

2. The most part (90–95%) of the hydrogenated product of crude Biosterin was in liquid state, and the authors could separate it by distillation into two mainly different portions, though the separation may not be yet completely perfect. The one portion: (6), (7), (8), (10), contains more than 80% carbon and 12–13% hydrogen; another portion (9) about 77% carbon, and 12% hydrogen. The latter distils out at a higher temperature than that of the former.

By Nakamiya :–

	Sample.	C %	H%	O %	Mol. W.	Iodine Value Wijs'	Ref. Index Abbe's
1	Crude Biosterin	80.80	10.62	8.58	--	—	—
2	C. III. Hyd. ppt.-75	81.48	12.27	6.25	—	146.6	—
3	C. IV. Hyd. & Hyd. ppt -75	81.27	13.05	5.68	—	21.01	1.4705
4	F. III. Hyd. Non ppt.	79.88	11.79	8.33	—	156.5	—
5	F. IV. Hyd & Hyd.	79.36	12.65	7.99	—	30.96	—
6	Distillate I of F. IV.	80.27	13.03	6.70	—	13.62	1.460(40°)
7	Dist. II. of F. IV.	80.28	13.13	6.59	—	—	1.465(40°)
8	X. 80–175°(2mm.)	80.09	12.89	7.02	243.7	33.98	1.465(20°)
9	Y. 175–195°(2mm)	77.19	12.29	10.62	296.4	31.90	1.469(20°)
10	L. 70–175°(2mm.)	79.99	12.79	7.32	240.4	47.80	1.4680(20°)

By Kawakami :–

Fraction & B. P.		Yield	C %	H%	O %	Mol. W.	Iodine Value Wijs'	Form and Color
1	130–205(15mm.)	1g.	80.77	11.86	7.37	—	104.5(4h)	Light yellowish liquid
2	205–210	4	81.31	12.40	6.29	277	95.9	Light yellowish oil
3	225–230	6	81.08	12.35	6.57	—	94.9	〃 〃
4	230–270	3	77.22	12.55	10.23	—	93.8	Browhish yellow oil
5	Residue	9	77.75	11.46	10.79	—	104.0	Dark brown syrup

3. During the purification of crude Biosterin, the authors obtained certain substances precipitable in aceton at −75°C. The most part of these were found as the mixture of cholesterol and a little Biosterin. Besides these, N. separated an unsaturated alcohol with m. p. 72–73°C. This unsaturated alcohol after hydrogenation changed into a saturated alcohol with m. p. 89–91°C, which already described above. K. obtained such a substance something like chymilalcohol.

4. N. confirmed, by feeding experiments, the decreasing of activity of vitamin A by hydrogenation, and also found that the activity of Biosterin may be lost if it is saturated with hydrogen atoms completely.

EXPERIMENTAL STUDIES UPON THE ALKALIMETRIC ESTIMATION OF AMINO ACIDS AND PEPTIDES BY THE METHOD OF WILLSTÄTTER AND WALDSCHMIDT-LEITZ.

By Etsuo Takamiya.

(*Biochemical Laboratory, Department of Agriculture, Kyushu Imperial University, Fukuoka*)

(Received Apr., 22nd., 1927.)

It was found by D. Vorlander[1] that glycocoll in alcoholic solution behaves as acid against phenolpthalein. Applying this fact Willstatter and Waldschmidt-Leitz[2] established a new method for the estimation of amino acids and peptides at a definite alcoholic concentration by alkalimetry.

Sorensen's Formol titration method has hitherto been adapted for estimating amino acids and peptides, although it requires considerable trouble. They, however, are readily estimated by the use of the W. and W. method.

I have studied the effects of temperature, dilution, indicator, acid and alkali and neutral salts upon this method, and also the adaptation of this method in the presence of acid and alkali and neutral salts, with following results.

1) There is no influence of temperature upon this method.

2) In the dilution experiments, one titration value was compared with another; the one was obtained by the immediate titration of amino acid

(1) Ann. d. Chem., **341**, 1, (1905)
(2) Ber. d. Deutsch. Chem. Ges., **54**, 2988, (1921)
(3) Per. d. Deutsch. Chem. Ges., **52**, 309, (1919)

solution of definite alcoholic concentration which had been allowed to stand for a difinite time, and the other by the titration of the amino acid alcoholic solution after dilution with water; no recognizable discrepancy was practically observed between them. From these experimental data it seems that there is no need especially to use an alkali-alcoholic solution for the titration.

3) From the fact obtained that an alcoholic solution of amino acids does not behave as acid against both rosolic acid and p–nitrophenol which have been adapted as indicators in place of phenolphthalein, it was ascertained, unlike the assumption of Vorlander[4] or Willstatter, that this phenomenon is entirely due to the effect of amino acid or peptide-alcoholic solution upon the indicator, phenolphthalein.

4) It was found that the titration value for amino acids is depressed in the presence of acid or alkali :– (a) the higher the concentration of acid or alkali, the greater is the degree of depression. (b) The degree slightly increases in the following order of NaOH, CH_3COOH and HCl. (c) Alanine is depressed to a slightly greater degree than glycocoll. (d) The lower the alcoholic concentration of the solution, the greater is the degree of depression.

5) This method can not be immediately adapted in the presence of acid and alkali. In such a case my experimental results confirm that amino acids and peptides are exactly by this method if the following procedures carried out: First, add 0.1c.c. phenolphthalein (1 %) to the sample solution to be estimated, neutralise until a distinctly pink color is obtained, and then make to a difinite alcoholic percentage; add again 0.9c.c. phenolphthalein and titrate it with a standard alkali solution until a distinctly pink color is obtained. The amount of alkali thus obtained corresponds to the quantity of amino acids and peptides.

6) It was found that Mn-chloride, Mn-sulphate, Mg-chloride, Mg-sulphate, and Mg-nitrate behave as acid against phenolphthalein in their alcoholic solution. Since the presence of these neutral salts misleads this method, it is necessary to remove them as their hydroxide by alkali before applying it.

ON THE MANGANESE CONTAINED IN THE MULBERRY LEAF.

By Shozo Bito.

(Received May 5th., 1927)

The manganese has in recent times been recognized as one of the essen-

tial elements in the growth of the plant.

The author has investigated the manganese contained in the leaf and flower of the mulberry tree.

The summary of the experimental results may be given as follows.

1. The mulberry leaf contains a certain amount of manganese, this suggests that possibly this metal may play a role in metabolism.

2. The manganese in the mulberry leaf increases according to the growth of the leaf.

3. The manganese contained in the mesophyll is greater than that in the vein and petiole.

4. The flower of the mulberry contains about the same amount of manganese as that of the leaf.

5. The quantity of manganese contained in the leaf varies according to the variety of the mulberry, in spite of its being cultivated in the same environment.

6. It is probable that the higher amount of the manganese has some connection with the discolouration of the leaf in the late autumn.

STUDIES ON ENZYME ACTION III.

ON THE SELECTIVE ADSORPTIONS OF UREASE AND PROTEINS IN A MIXED SOLUTION. (1)

By Matsunosuke Kitagawa.

(Received May 4 th, 1927)

For the purpose of applying the adsorption method to the purification of enzyme, it seems, as a rule, to be of the first importance to study the essential characters of the selective adsorptions of enzyme and proteins which exist as a mixture in the crude enzyme solution. Consequently I compared their adsorptive natures in a enzyme solution, which was obtained by the preliminay purification of the original urease extract from soy beans or jack beans, and examined the conditions favourable to their selective adsorptions. Finally I tried to establish a correlation between urease and some bean proteins, which has been previously discussed by J. B. Sumner, and came to the following conclusions.

A. On the preliminary purification.

1) Jack beans contain on the average fifteen times as much urease as soy beans, and the extraction of the urease from the materials with five times

their weight of water gave the best yield.

2) The protein-precipitant, such as lead acetate, removed over 85 per cent of protein in the original extract, but also at the same time about 65 per cent of the urease, so that the precipitant can not be used for the isolation.

3) From 27 to 47 per cent of the urease, which was adsorbed by the proteins precipitated with alcohol, was set free from the precipite by shaking with water, and about 70 per cent of it with baryta. In every case more or less protein was also dissolved.

4) As a result of the experiments, it was found that dialysis of the dilute original extracts in a collodion sac is the best method for the preliminary purification of the urease. By this method a solution containing about 80 per cent of urease and 12 per cent of proteins of the original extracts was obtained, the loss of urease being about 20 per cent, of which 5 per cent was by dialysis and 15 per cent by adsorption.

B. Experiments on Adsorption

1) The adsorption-value of the urease and proteins, namely the quantity of the substances adsorbed by 0.1g. of Al_2O_3, was studied with the above mentioned urease solution. In the case of the protein the adsorption-curve was approximately equal to Freundlich's adsorptionisotherm, but in the case of the urease, the larger the concentration of the extract, the more rapid was the decrease of the adsorption-value, as shown in the following table. The reason for this depends upon the fact that in a concentrated extract protein has stronger adsorptive power than urease, consequently a much larger surface of the adsorbent is occupied by the proteins, and the urease is expelled.

	enzyme solution				adsorption value		adsorption %	
	urease conc.		protein conc.					
Al_2O_3 %	before adsorp.	after adsorp.	before adsorp.	after apsorp.	urease	protein	urease	protein
1.31	269	10	248	37	200	16.2	96	85
0.97	〃	95	〃	51	179	20.2	64	79
0.66	〃	221	〃	99	74	22.9	17	60
0.33	〃	269	〃	165	0	25.3	0	33

(Remarks: Each unit used for urease and protein is different)

From the experimental results we see that the quantity of adsorbent is considered to be the neccessary factor controlling the selective adsorption, that is, by the use of a large amount of adsorbent comparatively more urease is adsorbed; and on the contrary, by the use of a small amount of it comparatively more protein is adsorbed.

2) When the solution was diluted, no effect was observed on the adsorption of the protein, but that of urease was markedly increased.

4) As the urease and proteins, which exist in the purified enzyme

solution obtained by means of dialysis, gave very different adsorption-curves and showed a different manner of adsorption on dilution, it is concluded that they are not identical but only a mixture.

STUDIES ON ENZYME ACTION IV.

ON THE SELECTIVE ADSORPTIONS OF UREASE AND PROTEINS IN A MIXED SOLUTION. (2)

By MATSUNOSUKE KITAGAWA

(Received May 4th., 1927)

As a biological extract such as an enzyme solution contains always several kinds of salt in different quantities, the influence of salts upon the selective adsorption of urease and proteins by aluminium hydroxide was examined in jack bean-urease solution, with the following results.

1) Inorganic salts generally make a salt-like adsorption with aluminium hydroxide at the solid surface of the adsorbent, but in the presence of urease and proteins a part of the salts is replaced by them, therefore the mechanism of the adsorption of the urease and proteins by aluminium hydroxide should be ascribed to chemical affinity, not to merely mechanical adhesion.

2) The salts are divided into two groups from the point of view of adsorption. The one like phosphates occupies the active surface of the adsorbent and diminishes the adsorption of the protein and urease, especially of the latter. The other like NaCl or CH_3COONa does not occupy the surface but merely changes the nature of the medium, and exerts some influence upon the adsorption, namely in the presence of certain phosphates it increases the adsorption of urease, but in their absence it decreases the adsorption.

The adsorption of proteins and urease is most favorable in the solution containing no salts.

Thus the selective adsorptions of the urease and proteins are influenced quantitatively by the nature and quantity of salts present. Consequently, in the presence of a moderate quantity of the adsorbent, and in accomparatively pure solution obtained by complete dialysis the urease is more easily adsorbed, but on the contrary, in a less pure solution obtained by insufficient dialysis, the proteins are more easily adsorbed. In the latter case, however, if NaCl or CH_3COONa is added to the solution, the degree of selective adsorption is reduced and the adsorption of urease is promoted.

3) The adsorptions of these substances were completed instanteneously

in a pure solution, but, in the presence of some salt, required some short intervals of time for attaining equilibrium.

4) The influence of hydrogen ion concentration upon the adsorption was remarkable, especially in the case of urease, in the solution containing some salts, namely in an acid range such as pH 5, the adsorption was very much accelerated, but in an alkaline range such as pH 7.5 it was largely retarded. In this case, the less the concentration of the salts, the less was the influence.

Urease is an amphoteric substance, as it was readily adsorbed by both kaolin and aluminium hydroxide.

5) The urease and proteins were not set free from their adsorption-compounds either by shaking with water or with glycocoll, acetate or NaCl, but were set free only by the addition of phosphate. In this case the proteins were more easily liberated than the urease. The liberation or elution was very insignificant especially in the case of urease at pH 4.5, but gradually increased with increasing alkalinity up to pH 7.5.

6) I have repeated several times Sumners' experiments on the crystallization of urease from the aceton extract, but unfortunately failed to justify his findings. On the other hand, my urease preparation obtained by his method was shown to be less active than that obtained by the method of dialysis. Consequently, I used the latter perparation for the examination of adsorptive factors.

As a result the experiments in regard to the adsorption-curves, the salt-influences and other factors, we came to the conclusion that urease and protein are not identical but exist as a mixture even in the purest preparation examined.

ON THE DEGREE OF SATURATION AND THE ADSORBED BASES OF JAPANESE SOILS.

SHIGERU OSUGI and YOSHIO SANO.

(Received May 17 th., 1927)

1) The dgree of saturation of Japanese soils was investigated by Hissink's method and it was found that the degree of saturation thus obtained was fairly in accordance with the reaction of the soils tested as shown in the following table.

soil.	(Degree of saturation)	PH.
1	77.1	6.76
2	19.4	4.35

3	28.9	5.95
4	73.3	6.81
5	31.4	5.38
6	33.2	4.35
7	49.8	6.46
8	17.4	5.98
9	13.0	5.29
10	24.1	6.34
11	45.3	6.56
12	60.6	6.99
13	61.4	7.12

It was found that the soils were saturated when the surrounding liquid reacts distinctly alkaline as PH 8.6–11 as in the following table.

Soil.	1	2	3	4	5	6	7	8	9	10	11	12	13
PH	9.15	9.25	9.15	11.67	9.60	8.95	10.20	10.30	9.10	8.60	9.05	8.62	9.55

2) The adsorbed bases of the soils were tested by Hissink's method and were compared with those of Dutch soils reported by him as shown in the following table which shows that in the soils tested, the amount of adsorbed calcium is smaller and those of Mg & Na are greater than those in Dutch soils.

% composition of adsorbed bases (in mg. equivalent)

	Ca	Mg	K	Na
Average of all soils tested	61.20	26.04	2.71	10.69
Average of the soils whose PH are greater than 6.	76.47	4.44	1.62	7.05
Average of the soils whose PH are smaller than 6.	43.40	39.53	3 99	14.94
Average of Dutch soils.	76-79	13	2-3	6-8

In the case of the alkali-soils of Formosa-island, the composition of the adsorbed bases lies between those of the alkali-soil and the flooded soil reported by Page & Williams as follows;

% composition of adsorbed bases (in mg. equivalent)

		Ca	Mg	K	Na
Alkali-soil of Formosa-island	A	14.31	11 21	11.37	60.11
	B	39.60	33.61	3.98	22.81

Result reported by Page & Williams.

Normal Soil	Ca	Mg+K+Na
	90	10
Flooded soil	48	52
Alkali-soil	0	100

3) The correlation between the composition of the adsorbed bases and the physical properties of the soils was investigated and it was not found any distinct relation and this was ascribed to the rather similar nature of the soils tested and was hoped to test this point further. The alkali-soils in Formosa island contain a considerable amount of Na and they became very plastic when the soluble salts were washed.

ON THE MECHANISM OF THE FRUIT-ESTER-FORMATION BY WILLIA ANOMALA SP.

By MASAKAZU YAMADA.

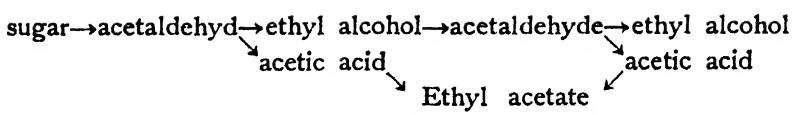
(Received Feb. 26 th., 1927)

It is a well-known character of Willa, Mycoderma and other few microbes that they produce fruit ester like ethylacetate in the various culture-media. T. Takahashi and H. Sato ascertained the fact with Willia anomala or aging yeast of saké, which was isolated from a deposit formed on the bottom of the vat during the storage period of saké, that ester flavour was formed from fermentable sugars, alcohl and ammonium-acetate originally existed in nutrient as a carbon source but from glycerine.(1) Lately U. Weber confirmed qualitatively with six kinds of organisms (Willia, Oidium, Pichia and Sachsia) that the flavour was produced in the culture media containing glucose, fructose, saccharose, maltose and the wort but not in the cases of lactose, dextrin, mannit and glycerine.

Further he showed that in the media of alcohol (methyl, propyl and butyl) preveously added to glucose yeast water the flavour of their acetic esters was felt and that in the media simply cotaining alcohol (propyl, butyl, isoamyl) their esters were formed but in the mixture of alcohols and organic acids their mutual esters were not formed. In similar experiments with the mixture of sugar and amino acid (glycine, alanine, leucine and tyrosine) only leucine gave the characteristic flavour of amylester(2). In saké brewing, willia sp. was said to be a kind of aging yeast but the flavour of ethyl ester produced by it was rather disliked. So it is interesting from the biochemical stand point and important for the practice to make clear the mechanism of ester formation by the organism.

The author found that willia was the most eminent species for aldehyde-production and that when aldehyde was held by means of the fixative, which was originally added to the medium containing either sugar or alcohol as a simple carbon source, no ester flavours were often recognized. Further experiments were made in the same direction and now it became obvious that in the ester formation the acid component should have prassed the aldehyde stage whether it came from sugar or alcohol. Thus, ethylalcohol and acetic acid from the fermentation of sugar and also from the secondary oxidation of alcohol may combine mutually forming ethyl acetate.

(1) J. Coll. Agri. Tokyo. 1, 227—68, 1911.
(2) Bioch. Z. 129, 208—16, 1922.



Whether the acid stage ought to be passed or not, is not yet accurately known because the fixative action on $CaCO_3$ is imperfect.

The fact is applied for alcohols which are easily oxdized into corresponding aldehydes by yeasts. Propyl propinate was formed from propyl alcohol and butyl butyrate from butyl alcohol. Various esters may be formed from the mixture of alcohols, some of which are produced in the amino-acid fermentation.

Miximum yield of ester (ethyl acetate) was obtained after 8 days in the culture containing 20-25% of sugar and also after 20 days in 4% of alcohol solution. Above 12% of alcohol there is not perceived ester flavour and so no anxiety necessiates for saké which contains at least 15% of alcohol. In author's experiments any production of aldehyde or ester flavour did not result in the medium containing ammonium-acetate as both corbon and nitrogen source by willia.

Experimental

Microbes used is Willia anomala var. saké I, Takahashi in all cases.

1. Optimum condition for ester formation.

A. Age of culture. Medium. koji extract (15°B) 100c.c. Grams of total ester produced per 100c.c. of culture is as follows:-

days	original koji ex.	2	5	8	12	30
ester (g)	0.2182	0.3698	0.6242	0.6424	0.5584	0.3887

B. Optimum concentration of both sugar and alcohol.

Medium: a. Hayduck's solution.

b. Modified Hayduck's solution (alc. instead of sugar)

a		b	
Concentration of sugar %	total ester per 100c.c. g.	Concentration of alcohol %	total ester per 100c c. g.
1	0.0968	1	0.0915
2	0.1302	2	0.1619
5	0.1848	4	0.3450
10	0.4206	6	0.2517
15	0.4664	8	0.3168
20	0.5245	10	0.1461
25	0.5086	12	0.0141
30	0.4136	15	0.0141

2. Production of ester with or without the fixative for aldehyde.

i. Sugar solution: Medium. a. Hayduck's solution (2% of sugar) 500c.c.

b. a + $CaSO_3$ 20g.

If concentration of sugar be 10%, the amount of the fixative is too weak to hold aldehyde sufficiently.

age of culture	PH	ester % (Volatile)	ald %	remarks
1	6.2			strong flavour
3	3.8	0.0774	0.00141	thick film.
6	3.8	0.1162	0.00253	"
9	3.8	0.0651	0.00148	"
12	3.8	0.0827	0.00077	"

b

age of culture	PH	ester % (Volatie)	ald %	alc. %	remarks
1	5.6				
3	5.6	0.0343	0.00933		
6	5.0	0.0440	0.04327	0.0918	thin film
9	5.0	0.0475	0.07490		no flavour
12	5.0	0.0580	0.10099	0.1505	slight flavour.

ii. Alcohol solution: Medium. a′ modified Hayduck's solution(Alc. 5% instead of sugar) 300c.c.
b′ a′ + $CaSO_3$ 20g.

a′

age of culture	PH	ester %	ald. %	remarks
1	6.2			strong flavour
13	3.8	0.1267	0.00933	thick film
23	3.8	0.2901	0.00594	"
30	4.0	0.1219	—	"

b′

age of culture	PH	ester %	ald. %	remarks
1	5.6			
13	6.4	0.0440	0.04897	film
23	6.2	0.0528	0.12559	no flavour
30	5.4	0.0792	—	"

The quantities of ester in (i b) and (ii b′) are under the limit of analytical error caused by aldehyde.

It is not due to the reversible action of alkality shown by $CaSO_3$ that no flavour of ester was recognized, because when PH value of the medium was regulated to 6.8 – 7.6 by KOH and amino acid as buffer, ester-flavour was already felt at PH. 6.4, while initial PH of the medium with $CaSO_3$ was 5.8.

3. In the case of higher alcohol.

i. n-Propyl alcohol:

Medium: Alc. 10c.c. $(NH_4)_2SO_4$ 0.5g. Hayduck's min. sol. 4c.c. water 186c.c.

microbes: yeast mud in the same size as 4 peas.
After 9 days the flavour of propyl propionate was recognized.
After 20 days: ester 0.1756% aldehyde. 0.00765%

ii. n-Butyl alcohol: medium. 3% alcohol solution.
microbes, the same as above.
After 20 days slight ester-flavour was felt.

ON THE ORIGIN OF ALDEHYDES IN FERMENTATION PRODUCTS, I. (ACETALDEHYDE)

By MASAKAZU YAMADA

(Received Feb. 26 th., 1927)

The important rôle of acetaldehyde in saké-brewing has precisely been investigated[1] and now it is a question to determine its origin, cause of occurrence and destiny for the practical use. Many researches for the source of acetaldehyde as a by-product in alcoholic fermentation have been made[2] and it is eventually supposed that the aldehyde is not formed as an inter mediate product in the fermentation of sugar, but may arise from the secondary oxidation of ethylalcohol, although no conclusive evidence has yet been obtained.

On the one hand in many experiments for aldehyde production by several microbes[3] generally the fixative was used and so their results can not be applied directly for the case of natural sugar fermentation. Therefore, the author observed the aldehyde formation by microbes and its optimum conditions in two cases, viz., the aldehyde production in acompaniment to the fermentation of sugar and that from the oxidation of alcohol, established their relation, which had not yet been attempted and confirmed exactly that most part of acetaldehyde produced as a by-product in alcoholic fermention of sugar originated from secondary oxidation of ethyl-alcohol. The important factors that influence

(1) M. Yamada: J. Agri. Chem. Soc. Jap. **1**, 109—110, 1924.

(2) A. Trillat: Compt. rend. Acad. **146**, 615—47, 1908; A. Trillat and Sauton: Ibid. **146**, 996—9, 1908; **147**, 77—80 1908; E. Buchner, U. Langheld, S. Skraup: Ber. **47**, 2550 1914; S. Kostytschew: Ibid. **45**, 1289—93, 1912; S. Kostytschew; Z. Physiol. Ch. **79**, 130—145, 1912; C. Neuberg u J Kerb: Bioch. Z. **43**, 491—99, 1812; **58**, 158—70, 1913 **64**, 251. 1914; J. Laborde: Ann. Jnst. Past. **31**, 215, 1917.

(3) A. Harden: J. Ch. Soc. **79**, 610, 1901; E. R Harding and Z. Ostenberg: J. Infect. Dis. **11**, **109**, 1912; G. G. de Bord; J. Bact. **2**, 309, 1917; C. Cohen: Bioch. Z. **112**, 139—43, 1920; W. H. Peterson and E. B. Fred: J. Biol. Ch. **44**, 29—46, 1920; C. Neubery u. C. Cohen: Bioch. Z **122**, 204—44, 1921.

the formation of acetaldehyde are the kind and quantity of microbes, temperature of culturing, sugar-concentration or alcohol-concentration produced, age of culture and aeration.

Experimental

I. Acetaldehyde production in accordance with alcoholic fermenation of sugar.

Aldehyde was estimated by Ripper's method.

1. With several microbes: The figure is g. of ald. produced per 100c.c. of koji extract culture (10° Balling at 25° C), ( ) indicates days of culture, analysed during which the fermentation appeared to end.

Willia anomala var Saké IV.	0.07235 (12)	Monilia candida	0.02610 (19)
Zygosacch. soja A	0.02020 (12)	Schizosacch. pambe	0.01746 (13)
Sacch. saké (94 kinds)	0.00136-0.02386 (7)	Mycoderma A	0.01482 (12)
Oidium G	0.01965 (14)	Mucor mucedo	0.01002 (13)
Rasse XII.	0.00695 (7)	Beer yeast Saaz	0.00635 (7)
Wine yeast	0.00484 (7)	Mucor amylomyces	0.00473 (14)
Aspergillus oryzae	0.00272 (7)	Pichia VI.	0.00188 (12)
Chalara mycoderma	0.00154 (12)		

2. Optimum temperature for aldehyde formation: 25—30°C (by 5 kinds of saké yeast)

3. Concentration of sugar: Medium: Kojiextract (at 25°C)
Microbes: Saké yeast Institute of brewing No.1 and C_1 C_4, Willia anomala var saké I (W_1)

g. of ald. and alc. % formed per 100c.c. of koji extract are following:-

	No. 1		C_1		C_4		W_1	
	Ald. g	Alc.%	Ald.	Alc.%	Ald. g	Alc.%	Ald.g	Alc. %
5°Balling after 9days	0.00730	1.85	0.00621	2.25	0.01644	2.2	—	—
15°B after 10days	0.01449	7.0	0.02227	—	0.04772	6.4	—	—
20°B after 12days	0.01059	8.2	0.01882	8.8	0.04018	8.7	0.00771	—
25°B after 9days	0.00317	10.3	0.00950	10.6	0.00574	11.25	—	—
30°B after 13days	0.00389	13.5	0.00646	—	0.01096	13.5	0.01093	5.5

15-20% of sugar is thus optimum. The care must be taken so that the concentration of alcohol produced coincides well with the optimum concentration in the case of oxidation of alcohol.

4. Addition of mineral salts (K_2HPO_4, $MgSO_4$, $CaCO_3$, NaCl and K_2SO_4) to koji extract or the substitution of nitrogenous constituent by glycine, alanine[4], leucine, peptone, $(NH_4)_2SO_4$ and $(NH_4)_2HPO_4$ for asparagine in Hayduck's solution of controling of PH value from 2.6 to 5.8 by succinic or lactic acid exterted no special influence on the yield of acetaldehyde. Glucose, fructose, galactose mannose and glycerine instead of cane sugar gave the same as above.

5. Periods of culture: Medium: 1L. of koji extract 15°B at 25°C

(4) O. E. Ashdown and J. T. Hewitt: J. Ch. Soc. London. 97, 1636—48, 1910.

Microbes: saké yeast No. 1, C_1, C_4 and Willia(W_1)

G. of aldehyde and alcohol % produced per 100c.c. of culture are as follows:–

× Gas evolution ended

age of culture (days)	No. 1 Alc.%	No. 1 Ald. g	W_1 Alc %	W_1 Ald. g	age of culture	C_1 Ald. g	C_4 Ald. g
2	3 3	0.00256	0	0.00107	7	×0.00882	×0.01336
5	6.1	0.00289	1.75	0.00127	12	0.01124	0.02557
8	×6.6	0.00574	3.80	0.00265	22	0.01815	0.04794
10	6.8	0.00596	4.53	0.00658	30	0.02009	0.03774
12	6.5	0.00810	×4.40	0.01809	49	0.02851	0.03441
15	6.4	0.01045	5.40	0.03567			
21	6.3	0.02080	5.10	0.04352			
30	5.9	0.02170	5 09	0.03617			
40	5.6	0.02261	4.60	0.03014			
50	5.1	0.01781	4.80	0.01302			

This experiment shows the most important fact, namely, in general the aldehyde is formed only in a minute quantity at the close of fermentation and then gradually increases. The maximum yield reaches after 30—40 days.

6. Aeration: There is some production of acetaldehyde, even if no aeration be taken place. But in vacuum or when oxygen was removed by alkaline pyrogallol solution no formation was observed.

II. Acetaldehyde production according to oxidation of ethyl alcohol by microbes.

1. Microbes:–

Medium: a. Alcohol 3c.c. (Alc. 96.2% Ald. 0.004206%), asparagine 0.125g, Hayduck's mineral solution 1c.c. watsr 46c.c. (Named modified Hayduck's solution)

b. $(NH_4)_2SO_4$ 0.25g. instead of asparagine in a.

c. b + $CaSO_3$ 1g. Each two platinum ears were ionoculate.d

The figures indicate the increase of aldehyde per 100c.c. of culture after 31 days at 25°C.

	a		b		c	
Microbes	Rimini's test	aldehyde	Rimini's test	aldehyde	Riminis test	aldehyde
Monilia candida	++	0.04292	+	0.01893	++	0.03830
Rhizopus delemar	–	0 00150	±	0.00383	±	0.00533
Mucor mucedo	–	0.00091		—	+	0.05261
Mycoderma A	–	0 00150	+	0.02101	+++	0.07457
Zygosacch. Soja A	+++	0.04700	±	0.00338	+++	0.01044
Wine yeast	+	0.00500	±	0.00649	+	0.03086
Beer yeast Saaz	+	0.01317	±	0.00268	++	0.02511
Rasse XII	+	0.00908	+	0.00908	+	0.03378
Mucor amylomyces	+	0.00584	–	0.00286	++	0.02308
Chalara mycoderma	–	0.00036	–	0.00144	+	0.09106

Pichia	−	+	+	0.00845	++	0.07584
Red torula	−	0	±	0.00390	++	0.00482

2. Identification of aldehyde.

i. 3 L. of koji extract (10°B) culture of Willia IV. ii. 3 L. of the same as b in 1 inoculated with Willia IV. iii. Alc. 180c.c., $(NH_4)_2SO_4$ 7.5g., $(NH_4)_2HPO_3$ 7.5g., Hayduck min. sol. 30 c.c., water 2850c.c. inoculated with saké yeast.

	g. of ald. formed per 100c c. after 12 days at 25°C	p-nitrophenyl hydrazone		N (calculated for $C_8H_9N_3O_2$)
		M P	N (found)	
i	——	128.5°C	23 71%	23.46
ii	0 01569	126°	23.43	〃
iii	0.01688	126°	23.12〃	〃

3. Glycine, alanine, leucine, glutamic acid, peptone and $(NH_4)_2HPO_4$ in place of asparagin in the modified alcoholic Hayduck's solution or addition of methylene-blue or $ZnCl_2$ showed no effect on the yield of aldehyde.

4. Concentration of alcohol.

Medium: 100c.c. of modified alcoholic Hayduck's solution. Yeast: Each 4 platinum ears.

Natural state

Alc. c.c.	Saké yeast (after 31days) g. of ald. produced	Willia IV (after 15days) g. of ald. produced
1	0.00390	0.00185
2	0.00760	0.00297
3	0.01078	0.00507
4	0.01102	0.00839
6	0.01511	0.04135
8	0.03676	0.02166
10	0.02355	0.01730
12	0.00853	0.00683
14	0.00343	0.00124
16	0.00215	—
*20	0.00568	—
*30	0.00217	—
*40	0.00003	—

× Fixation

Alc. c.c.	$CaSO_3$ added	Saké yeast (after 41 days) ald. g. per 100.cc.	Willia I (after 42 days) ald. g. per 100c.c.
0.1	1g.	0 00256	—
0.2	1	0.00186	—
0.3	1	0	—
0.4	1	0.01165	—
0.5	1.5	0.04426	0.06838
1	3	0.05201	0.12040
2	4	0.03641	0.15047
3	4	0.02740	0.17075

5	5	0.02013	0.17262
8	3	0.00984	0.09592
10	3	0.00560	0.03239
12	3	0.00330	0.00347
15	3	0.00765	0.00202

× Amm. sulphate 0.25g. instead of asparagine.
* Yeast mud was added in the same size as a pea.

Optimum concentration is 6–8% in the natural state and 3–5% in the fixation.

III. Comparison of aldehyde production in both sugar fermentation and oxidation of alcohol when the fixative is used.

Medium: a. 800c.c. of koji ex. 15°B+50g. of $CaSO_3$ + saké yeast 4 platinum ears.

b. alcohol 50c.c. water 950c.c. yeast mud, 10g.

G. of aldehyde produced per 100c.c. of culture is as follows:–

after 25 hours	0.14195	after 25 hours	0.01166
" 45 "	0.20900	" 3 days	0.01432
" 94 "	0.25622	" 4 "	0.01777
" 7 days	0.22155	" 6 "	0.02414
" 11 "	0.22692	" 13 "	0.05512
" 26 "	0.28508	" 20 "	0.04656
" 45 "	0.41180	" 39 "	0.04303

If all the aldehyde in a 25 hour old culture in the series came from alcohol, it must be concluded that alcohol in nascent state is quite readily oxidized. But that would not be the case, and perhaps the aldehyde would have been arisen directly from the sugar as an intermediate procuct to alcohol as Neuberg's theory supposes. Whether some part of the minute quantity of aldehyde generally produced during the fermentation stage comes from sugar or not would not be decided until new method of detection for alcohol and aldehye is deviced and makes the relation of their fluctuation clear.

ON THE ORIGIN OF ALDEHYDES IN FERMENTATION PRODUCTS II.

OXIDATION OF ALCOHOLS BY MICROBES.

By Masakazu Yamada.

(Received Feb. 26th., 1927)

The existence of isobutyl-, isovaler- and other aldehydes in fermentation

products has often been reported,[1] and the aldehydes except furfurol like substance have been supposed to come from amino-acids as the hypothetic intermediate products in the so-called amino-acid fermentaion.[2]

Yet, nobody has actually isolated any aldehydes in the middle stage from amino-acid to alcohol.

On the one hand, with regards to the oxidation of alcohols by microbes there have been many researches concerning mannit, sorbit or other polyvalent alcohols,[3] but for the monovalent alcohols only a few works have been carried out.

Seifert proved that acetic acid bacteria could oxidize alcohols into the corresponding acids.[4] C. Neuberg and F. F. Nord established by the use of that the intermediate product from alcohol to acid in acetic acid fermentation was acetaldehyde.[5] Further,Trillat and Sauton said that the aldehyde formation from alcohol by yeasts was specific for ethylalcohol.[6]

The author attempted to oxidize alcohols hy two kinds of yeast and obtained propyl-, n-butyl- isobutyl-, isovaler- aldehyde from corresponding alcohols and acetone from isopropy alcohol. In order to obtain a sufficient quantity of these aldehydes or ketone from derivatives, the fixative was used. Only propion aldehyde and acetone may be obtained in a quantity without it.

In the first place, it was found that the difficulty of oxidation seems to be conversely proportional to the solubility of alcohol in water. This fact may explain an origin of aldehydes in fermentation products.

In the next place, it was observed that sake yeast could oxidize ethyl-alcohol as far as into acetic acid; this fact foretells the destiny of acetaldehyde and also explains a origin of acetic acid in fermentation products. Lastly, the author proved that acetic acid bacteria were capable of oxidizing propyl alcohol into propionic acid and that the inertmediate product was propyl aldehyde.

Experimental

I. Aldehyde, ketone production in modified Hayduck's solution.

Alcohol was used instead of sugar in Hayduck's solution.

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(1) Ordonneau: Z. Spirit. Ind. **11**, 183, 1888; F, Ehrlich: Ber. **40**, 1027—47, 1907; S. Kodama: J. Ch. Soc. Japan. **43**, 956—81; 948—56, 1922; T. Takahashi: J. Agri. Japan. **65**, 1904; R. Mitsuda: J: Ch. Soc. Japan, **30**, 335—48, 1909; T. Taira: Report. Depart. Ind, Formosa, **8**, 1—7, 1925; K. Nishizaki: J. Pharm. Soc. Jap. **285**, 1029, 1905,

(2) O. E Ashdown and J. T. Hewitt: J. Ch. Soc. London **97**, 1636—48. 1910.

(3) G. Bertrand: Compt. rend. Acad. **122**, 900,·1896; **126**, 762, 812, 984, 1897, **127**, 124, 728, 1898; Kling: Ibid. **128**, 244; **12**. 1899, Vincet u, Delachnel: Ber. **32**, 541. 1899 Boutroux: Ann. Inst. Past. **2**, 308, 1887; Alsberg: J. Biol. Ch. **9**, 1, 1911.

(4) C. **3**, 337, 897;

(5) C, Neuberg. u. F. F. Nord: Bio. Ch. Z: **96**; 133, 1919.

(6) A. Trillet et Sauton: Compt. rend. Acad. **147**, 77—80, 1908.

It was tested previously that no aldehyde was produced from asparagine by microbes, in absence of sugar.

Character of alcohols used :

	Manufacturer	aldehyde contents
n-propylalcohol	Merck	0.00764%
n-butyl "	"	0
iso-butyl "	" B. P.108°	0.00482"
isoamyl "	Prepared by author B. P. 128—130°	0.02267"

Aldehyde production :-

Yeast was added in mud of the same size as a pea.

Aldehyde was estimated according to Ripper's method.

Yeast	age of culture	alcohol	total volume of culture	$CaSO_3$ g.	G. of aldehyde increased per100c c.	remarks
sake yeast	30 cays	methyl 2c c.	50c.c.	0	0	Rimini's test-
"	30	"	"	1	0	"
"	38	n-propyl 3	"	0	0.01017	
"	34	"	"	1	0 02484	
"	38	n-butyl 3	"	0	0.00347	
"	34	"	"	1	0.00509	
"	33	iso-butyl 3	"	0	0.00143	$(NH_4)_2SO_4$ instead of asp.
"	34	iso-amyl 3	"	1	0.00688	"
"	31	iso propyl 2	"	1	0	Rothera's test ++
"	31	glycerine 3	"	0	0	
"	31	" 6	100	2	0.00336	
"	31	Mannit 3	50	0	0.00140	
	31	" 6	100	2	0 00131	
wilhia I	31	Methyl 3	50	1	0	Riminis teat —
" IV	30	n-propyl 5	100	0	0.00252	
" I	31	" 3	50	1	0.00346	
"	33	n-butyl 3	"	0	0	
"	31	" 1	"	1	0.00167	$(NH_4)_2SO_4$ instead of asp.
"	33	iso-butyl 3	"	0	0.00111	
" IV	30	iso-amyl 5	100	0	0.00094	
" I	31	" 1	50	1	0.00369	

II. Identification of oxidation products.

Aldehyde and ketone production in dilute alcoholic solution with the fixative by saké yeast. (at 25°C)

	alcohol c.c.	$CaSO_3$	Yeast mud	total volume of culture	g. of aldhyde produced per100c c.	age of culture
1.	n-propyl alcohol 40	20g.	23g.	2000c.c.	0.01923	14days
2.	n-butyl " 30	"	34	1500	0.02320	30
3.	iso-butyl " 20	"	40	1500	0.00437	27
4.	iso-amyl " 10	"	11.5	1500	0.01095	36
5.	iso-propyl " 15	15	46	1000	Rothera's test++	10

Character of p-nitrophenylhydrazones prepared.

	M. P.	Subst. g	Nc.c.	P.m.m.	T	N.found	Calculated for
1.	122°	0.1183	22.7	759.2	25°	21.43%	21.76 ($C_9H_{11}N_3O_2$)
2.	88–90	0.1075	19.9	755 7	25	20.57	20.30 ($C_{10}H_{13}N_3O_2$)
3.	126	0.0526	9.7	759.0	25	20.59	20.30 ($C_{10}H_{13}N_3O_2$)
4.	110	0.0846	14.4	758.7	23	19.20	19.01 ($C_{11}H_{15}N_3O_2$)
5.	149	0.1008	18.8	764.8	18	21.68	21.76 ($C_9H_{11}N_3O_2$)

III. Acetic acid formation from ethyl-alcohol by saké yeast.

Medium : ethyl-alcohol 240c.c. (alc. 96.2% ald. 0.002074%) water 2820c.c. yeast mud 57g.

Aldehyde and total acid after 66 days at 25°C was each 0.02038g. and 0.048g. per 100c.c. of culture.

Silver content of Ag-salt prepared from the distillate :–

Subst	AgCl	Ag. found	Ag. calculated for $C_2H_3O_2Ag$.
0.2062g.	0.1748g	63.78%	64.64%

IV. Oxidation of propyl alcohol by Bac. xylinum at 20°C.

Medium : a. propyl alcohol 30c.c., $(NH_4)_2HPO_4$ 0.5g. KCl 0.1g water 970c.c.

b. a + $CaSO_3$ 20g.

Microbes : Bacteria-mud developed in 1 L. of koji extract.

(a.) Total acid after 35 days 0.2738g. per. 100c.c.

Silver content of Ag-salt prepared from the destillate.

Subst.	AgCl	Ag found	Ag calculated for $C_3H_5O_2Ag$
0.3282g.	0 2578g	59.11%	56.62%

(b.) Aldehyde after 32 days 0.07948g. per 100c.c.

Character of p-nitrophenylhydrazone prepared.

M.P.	Subst.	N		N.found	N.Calc. for $C_9H_{11}N_3O_2$
1210	0 1068g	20 9c c.	(25°C 756 2 mm)	21 76%	21 76%.

ON THE PRODUCTION OF ACETOIN AND 2.3-BUTYLENGLYCOL BY MICROBES AND THEIR DISTRIBUTION IN FERMENTATION PRODUCTS.

By Masakazu Yamada and Kanroku Kurono.

(Received Apr. 22nd , 1927.)

It has often been reported that the reducing substance in vinegars is

acetyl methyl-carbinol.[1]

On the other hand, the production of acetoïn and its related compound, 2.3- butylenglycol by microbes, especially by several bacteria has repeatedly been described under the name of butylen glycol-fermentation in the culture media containing glucose, fructose, mannit,glycerine or Ca-lactate as a carbon source.[2] As to the production of both compounds by yeast Kluyver, Donker and Visser't Hooft confirmed that the glycol was formed everytime while acetoïn rarely in the sugar solution.[3]

The mechanism of their production is not yet accurately known except the explanation put forward by C. Neuberg and their associates. They say that acetaldehyde which is formed in nascent state as an intermediate product in the fermentation of the sugar undergoes an acyloin like conjugation with acetaldehyde, when the latter is added to the fermented liquid, by aid of carboligase and the acetoin thus formed, is reduced into butylenglycol phytochemically.[4] But Elion obtained acetoïn from the dilute ethylalcohol or acetaldehyde solution by the yeast.[5]

Lately T. Taira reported on the distribution of the butylenglycol in Japanese fermentation products, without referring to acetoin. Therefore the production of these two compounds by microbes and their distribution in main fermentation products have been newly tested.

The results are as follows :-

1. Bacteria produced a considerable quantity of both compounds.

2. Yeasts and a fungus produced a little of both except Pichia and Chalara.

3. The butylenglycol existed in saké(fresh and old), putrid saké, shōyu, tamari-shōyu, wine, beer and vinegar, that is to say, in almost all kinds of fermentation products; it may be regarded therefore as an ordinary component of all fermentation products.

4. Acetoïn was found in putrid saké, shōyu, tamari-shōyu and vinegar.

5. Acetoïn may be taken as a component which distinguishes the imitated vinegar from the fermented one, for it was not detected in the former.

6. Also the detection of acetoïn may be used to distinguish saké and putrid saké while it must be careful that a minute quantity was found in

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(1) C. A. Browne: J. Pastureau:
Farnsteiner:

(2) A. Harden. u. G. S. Walpole: Proc. Roy. Soc. B. 77, 399, 1906; Harden u. Norris: Ibid. 84, 492. Ruot: C. r. Acad. 157, 247-99, 1913; M. Lemoigne: Ibid. 155, 792-95: 157, 653-55; 177, 652-54; C-r. Soc. Biol. 82, 984, 83; 336-8; 88,467.

(3) Bioch. Z. 161, 361, 1925.

(4) C. Neuberg u. E. Rein forth: Bioch. Z 143, 553, 1923.

(5) Elion: Ibid. '40-44,

"moto" – culture of saké yeast in saké brewing and koji extract culture fermented by saké yeast.

7. There was no production of both compounds in the dilute alcohol solution cultivated with saké yeast or acetic acid bacteria contrary to Elion's experiment.

Experimental

Medium : for yeast and fingus; 50c.c. of koji extract (10°Balling) for bacteria; 50c.c. of neutralized koji extract (10°B) to which 1.5g. of $CaCO_3$ is added.

Microbes : Each 1 platinum ear was inoculated.

Detection : By Lemoigne's method developed by Kluyver and his associates. (3) (Formation of Characteristic red crystal of Nickel dimethylglyoxim.)

Production or existence is shown in the following table.

O was not tested.

Microbes	Sample	Acetoin	2.3-butylenglycol	age of culture
B.lactis 1.	15c.c.	+++++	++	12 days
2.	〃	++	−	12
B.butyricus Hüppe	〃	+++++	+++++	12
B.subtilis	〃	+++++	+++++	12
B.pyocyaneus	〃	+++++	++++	13
B.mesentericus	〃	+++	++	13
B coli communis	〃	+++++	+++++	13
B proteus Vulgaris	〃	+++++	+++++	13
B acetosum xylinum Brown	〃	+++++	+++++	13
〃 (glucose solution)	〃	+++	++	13
〃 (3% alcohol Sol.)	〃	−	0	13
Zygosacch. soja A	〃	+	++	10
Schizosacch pombe A	〃	++	++	11
Pichia IV	〃	−	−	11
Oidium A	〃	++	++++	11
Mucor mucedo	〃	++	+++	11
Chalara mycoderma	〃	−	+	11
Monilia candida	〃	++	+++++	11
Mycoderma A	〃	+	++	12
Willia anomala var saké I	〃	+	++	12
koji extract (control)	〃	−	−	0

Subst.	Vol	extractive agent	Acetoin	Butylenglycol
saké (fresh)	15c.c.	−	−*	++
〃 〃	650	ether	−	0
〃 〃	〃	$CHCl_3$	−	0
〃 (old)	〃	ether	−	++

Shōyu	150	$CHCl_3$	++	++++
Tamari-shōyu	100	$CHCl_3$	++	++
wine	15	-	0	++
beer (Yebisu)	500	$CHCl_3$	-	+
〃 〃	15	-	-	-
vinegar	15	-	++	+++
moto	15	-	-	+
〃	900	$CHCl_3$	+	0
putrid saké	15	-	+	++
Koji ex. fermented by saké yeast after 6 days	15	-	-	±
〃	500	$CHCl_3$	++	+
Koji extract(not fermented)	2000	ether	-	-
5% alcohol solution with saké yeast	1400	ether	-	-

ON THE PHYSIOLOGY OF RHIZOPUS SPECIES.

By Teizo Takahashi, Kin-ichiro Sakaguchi and Toshinobu Asai.

(Received June 20th., 1927.)

Part. V. The preliminary research on the occurrence of zymase and carboxylase in Rhizopus species.

Part. VI. The verification of the occurrence of zymase in Rhizopus species.

Part. VII. On the formation of ethyl alcohol from acetic acid by acetone-Rhizopus (Rhizopus treated by acetone.)

Part. VIII. On the formation of ethyl alcohol from malic acid by Rhizopus species.

Part. IX. On the formation of ethyl alcohol from malic acid by ace'one-Rhizopus.

As it is well known, that Rhizopus species, as a rule, play very important role in many kinds of the manufacture of alcoholic beverages, in saccharifying as well as in the formation of alcohol, we have a good reason to assume the existence of zymase and carboxylase in the fungus. Nevertheless, the confirmation of their existence lacked ever since. The authors devise to verify the occurrence of both zymase and carboxylase in the fungus foiled in the case when they allowed to follow the method of E. Buchner, as schemed in the case of yeast zymase. By the determination of alcohol produced by acetone-Rhizopus viz :- fungus growth treated by acetone, we could safely conclude the presence of zymase in this fungus.

The existence of carboxylase could not be confirmed yet, not only in the pressed juice of fungus, but also in acetone-Rhizopus.

The production of alcohol from acetic acid was affirmed, although the quantity of alcohol produced was not satisfactory great, by the dead cells of the fungus. There must exist some substance of an enzymic nature.

An analogous phenomenon was perceived in the formation of alcohol from malic acid either by fungus itself or by acetone-Rhizopus viz :- the dead cells.

From these data together with all the facts, which the authors have substanciated already, this fungus produces alcohol from many organic acids, such as acetic-, malic-, tartaric-, fumaric-, and gluconic acids and especially from the first two acids, alcohol formation is ascertained even by the action of the dead cells namely by special enzymes.

The evolution of CO_2 from organic acids by yeast or zymin is already

affirmed by C. Neuberg and L. Tir[1] and it will be perhaps the same nature of ours, although their aim have been to prove the occurrence of carboxylase.

However, if pyruvic acid is only intermediate, nearest to alcohol, product of ethyl alcohol formation, these alcohol giving acids must always and decidedly derived to their ends to pyruvic acid. For the derivation or degradation of these organic acids to pyruvic acid, therefore there must come into existence many enzymes, perhaps for each stage of the degradations. The researches for these enzymes will be followed hereafter.

The Experimental to PART V.

I. RESEARCH ON ZYMASE.

Fungus used :- Rhizopus oryzae.

The culture was obtained from "koji" extract (12°B), as culture medium, during 10 days at 25-30°C.

A). The preparation of pressed juice and research for zymase.

100g. of the culture of fungus was washed several times with distilled water and the mass of fungus was chopped into small pieces with sterile scissors, provided the treatment of the mass between sterile filter papers to remove water off as much as possible. To these fine pieces of the fungus, 100g. of fine silver sand and 20g. of diatom earth were mixed and in a porcelain mortor the mixture was ground until it changed into a consistency of dough. The doughy mass was wrapped in a silk cloth (Habutai), and submitted to a pressure of hand press to press out the juice, which attained about 30c.c. in the first pressing, to which added another 20c.c. of it in the second pressing, provided the addition of water and regrinding before the management.

The juice thus gained was introduced into Einhorn's fermenting tube with addition of glucose and antiseptic, to observe how the evolution of carbon dioxide comes forth, as tabulated below :-

1) Pressed juice 10 c c. + glucose 20 % + toluol 0 1 c c
2) Pressed juice 10 c c. + glucose 40 % + toluol 0.1 c.c.
3) Pressed juice 10 c c + glucose 20 % + toluol 0.1 c.c.
   + Buffer mixture with phosphate.
4) Pressed juice 10 c c + toluol 0.1 c c.
5) Glucose (20%) 10 c c. + toluol 0.1 c.c.

After 42 hours at 25-30°C, we could observe just a trace of gas evolved, which was almost equal to that of control (No. 4. in the table).

Thus we failed to prove the occurrence of zymase, but a little improvement of the instrument to collect the carbonic acid evolved to its last trace,

there came out the decisive positive prove of zymase. It will be reported before long.

B). The preparation of acetone-Rhizopus viz: fungus growth treated by acetone and research on zymase.

The preparate of acetone-Rhizopus was made by quite the same method as done in the case of acetone-yeast (zymin), after Albert, and its fermenting power was tested with Einhorn's tube as shown in the case of pressed juice. (refer heading A.) The results are tabulated below :-

			Gas evolved after 42 hours at 25–30°C.
1)	Glucose (20%).	10 c c. dead fungus 0.5 g. toluol 0.1 c c	Almost none
2)	Glucose (40%).	10 c c. dead fungus 0.5 g toluol 0.1 c c.	Almost none
3)	Glucose (20%).	10 c c. dead fungus 0.5 g. toluol 0.1 c.c. + buffer mixture with phosphate.	Almost none
4)	Glucose (20%)	10 c.c + totuol 0.1 c c.	none
5)	Distilled water	10 c c. + dead fungus 0.5 g + toluol 0.1 c c.	none

II. Research on Carboxylase.

The pressed juice of the fungus and the mentioned acetone-Rhizopus were tested for carboxylase in Einhorn's tube in anologous way to that of for zymase. The data are tabulated below :-

A). Pressed juice.

			Gas evolved at 25°–30°C, aft. 18 hours.
1)	Pyruvic acid (1%)	5c.c. + pressed juice 5c c. + toluol 0.1c.c.	Almost none
2)*	Pyruvic acid (1%) + K_2HPO_4 (1.5%)	5c c. + pressed juice 5c c. + toluol 0.1c c.	Almost none
3)	Pyruvic acid (0.5%)	10c.c. + toluol 0.1c.c.	none
4)	Distilled water	5c.c. + pressed juice 5c c. + toluol 0.1c c.	none

B). Acetone-Rhizopus.

			Gas evolved at 25–30°C, after 18 hours.
1)	Pyruvic acid (0.5%)	10c.c. + fungus 0.5g. + toluol 0.1c c.	about 02.c c.
2)(2)	Pyruvic acid (0.5%) + K_2HPO_4 (0.75%)	10c c. + fungus 0.5g. + toluol 0.1c c.	about 0 2c.c.
3)	Pyruvic acid (0.5%)	10c c. + toluol 0 1c.c.	none
4)	Distilled water	10c c. + fungus 0.5g. + toluol 0.1c c.	none

Thus, the authors were unable to substantiate the occurrence of carboxylase in Rhizopus, but they have very fine reason to be so and that will be shown later on.

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* Ph of the mixture was 3.5.

2) Ph of the mixture was 3.5.

Part VI.

The verification of the occurrence of zymase :- The formation of alcohol from glucose by the said acetone-Rhizopus.

Fungus - Rhizopus G 34 + 25g sucrose + 10g $CaCO_3$ — Culture medium - 500c c of Koji extract 10 days culture at 25°C.

The preparation of the durable fungus (acetone-Rhizopus) was quite same as described in part V, but the apparatus was changed to common flask with the aim to determine alcohol formed at the end of the test, provided with all means suitable for an aseptic working The results are described in the table as follows –

				After 40 hrs at 25–30°C		
					Glucose in 100c c	
		Ph		Alcohol v %	decomposed (g)	remained (g)
A)	Glucose 10g, n/15 KH_2PO_4 9c c, n/15 Na_2HPO_4 1c c } 100c c	5 3	+ 5g dead fungus	0 20	1 26	8 74
B)	〃 〃	5 3	+ 〃 boiled 2 hrs	0.07	0 89	9 11
C)	Distilled water 90c c, n/15 KH_2PO_4 9c c, n/15 Na_2HPO_4 1c c } 100c c	5 3	+ dead fungus 5g	Iodform reaction positive	—	—

From this, the authors are inclined to conclude that Rhizopus species contain an enzyme by whose action ethyl alcohol is formed from glucose and it may be called zymase defined by Ed. Buchner

Part VII.

The formation of ethyl alcohol from acetic acid by acetone-Rhizopus.

Rhizopus species, culture medium and conditions for growth of the fungus are quite same as described in part VI. The results are shown in the table below :-

				After 82 hrs at 25–30°C		
					Acetic acid	
		Ph	Dead fungus	Alcohol v %	decomposed (g)	remained (g)
A)	n/, Acetic acid 15c c, n/5 Na-acetate 75c c, n/5 K_2HPO_4 10c c } 100c c	5 2[3]	5g	0 13	0 3487	0 7320
B)	〃 〃	〃 boiled	〃 2 hours	0 07	0 2647	0 8160
C)	Distilled water 90c c, n/1, KH_2PO_4 9c c, n/15 Na_2HPO_4 1c c } 100c c	5 8		Iodform reaction positive	—	—

The authors conld not deny the occurrence of an enzyme in Rhizopus species, which play an important rôle for the formation of alcohol from acetic acid.

3) It correspond to 1.0807 g in 100 c c water

Part VIII.

The formation of ethyl alcohol from malic acid by Rhizopus species.

Rhizopus sp. :- Rhizopus G. 34. Culture medium :- Koji-extract (6°B) + 5% of glucose

After 10 days culture in this medium at 28–30°C, the growth of fungus covered whole the surface of the medium. At this stage, the culture medium under the growth was decanted and washing several times with the sterile distilled water, until there remains any indication of the presence of acids, ethyl alcohol and sugars, culture media (a, b and c) anew was introduced from the side tube. (refer to Bulletin of Agr. Chem. Soc. Jap., Vol. 3. No. 3. p. 39) After 50 hours at 28–31°C., alcohol produced was determined, and in the meanwhile the fungus mass was held immersed under the fluid. The results are tabulated below :-

	Culture media	Weight of fungus. g. (dry matter)	PH	Acidity. c.c. of $N/_{10}$ NaOH to neutralize 5c.c. solut.		Alcohol. (in 100c c.)	Aldehyde (Schiff's reaction).
				Original.	After growth.		
a)	1.5g. malic acid (merk), 0.5 KH_2PO_4, 1g. K_2HPO_4, 300c.c. water	0 915	4.3	4 9	3.8	0.053g.	Positive.
b)	1.5g. malic acid, 300c.c. water	0 873	3.0	4.0	3.6	Iodform test positive.	Positive.
c)	0.5g. KH_2PO_4, 1g. K_2HPO_4, 300c.c. water.	0.899	4.9	—	—	Precipt. of iodform.	Positive.

Remarks :- At the end of the experiment, by the microscopic examination it was confirmed that the procedure had been going on in aseptic way.

Part IX.

The formation of ethyl alcohol from malic acid by acetone-Rhizopus.

The fungus used in this experiment was Rhizopus G. 34 cultured as noted in the part VI and the preparation of acetone-Rhizopus was quite same described in that part.

The dead fungus viz. acetone-Rhizopus was put into the special flasks as shown in a former paper[4] and adding media (a, b, c), respectively to each flask, held at 28–30°C during 50 hours, provided all aseptic control is concerned. At the end of the experiment the decrease by weight of flask, including contents, was taken as the weight of carbon dioxide evolved in the time. The last trace of carbon dioxide was driven off by passing a current of air, free from moisture and carbon dioxide, warming to about 60°C the contents during the management. The results are indicated in the table below :-

4) Bulletin of the Agric. Chem. Soc. of Japan. Vol. 3. No. 3.

	Culture media	Weight of fungus(g.) (Acetone-Rhiz.)	P_H	Alcohol g. in 70c.c.	Alcohol w %	CO_2 (g.)	Malic Acid. Applied. (g.) in 70c.c.	Malic Acid. Remained. (g.) in 70c c.	Malic Acid. Decomposed. (g.) in 70c.c.
a)	0.7g. Na_2HPO_4 $12H_2O$, 0.6872g mal'c acid, 100c.c. water.	1.5	4 6	0.077	0.11	0.0435	0 481	0.352	0.129
b)	Do	1.5	4.6	0.084	0.12	0.037	0.481	0.366	0.115
c)	0.7g. Na_2HPO_4 $12H_2O$, 0.4g. KH_2PO_4, 100c c. water.	1.5	5 2	0.021	(0.03)	0.0105	—	—	—
d)	0.6872g. malic acid, 100c.c. water.	—	—	—	—	0.007 (ave.)	0.481	—	—

Remarks :- In a) and b) we observed in madia crystals, very similar to that of fumaric acid, and it is rather out of question that the formation of the acid from malic acid happened by an enzyme specific for it. It will be substanciated in a near future.

(This paper was read already in the meeting of the Agricultural Chemieal Society of Japan, on February, 1927)

ON THE DIFFERENCES OF BREWING BARLEY ACCORDING TO SPECIES.

II. THE KINETICS OF THE ENZYMATIC DECOMPOSITION OF THE PROTEINS

By Yukihiko Nakamura.

(Received July 16th., 1927.)

Introduction.

Attempting to study the differences of brewing barley according to the species, the author published his first report stating the physico-chemical differences of the proteins. The present investigation was carried out to study the kinetics of the enzymatic decomposition of the protein for the purpose of getting a partial knowledge concerning the constitution of the protein molecules.

The fact that an enzymatic decomposition of a protein has a relation to its constitution was accepted by many investigators, and in recent days, Ssadikow, Waldschmidt-Leitz and Sorensen have also published the same idea in their works.

Experiments.

From three species of barley, -Golden Melon, Chevalier and Hokudai No. 1,- produced in the 11th, 12th and 13th years of Taisho, the author prepared proteins soluble in 10 % NaCl solution, in 70 % alcohol and in 0.2 % NaOH solution respectively. To the protein were added Sorensen's M/15 phosphate mixture of the P_H value 7.731 and a 1/7000 water solution of trypsin (made by Grübler). And also to the protein were added the mixtre of M/5 HCl and M/5 KCl (P_H value 1.2) and a 1/7000 water solution of pepsin (made by Merck). The mixtures were kept in an incubator at 40° ± 0.5°C. for 0, 15, 30, 45, 60, 90, 120, 150, 180 and 210 minutes, then the undigested protein was precipitated by an addition of the trichloroacetic acid solution. Taking the mixture of 0 minute's enzymatic action as a standard, a nephelometric comparison was carried out by means of a Duboscq's nephelometric colorimeter.

Discussion and Conclusion.

To make his experiments coincide with the equation as exactly as possible, the author has combined the equation of equi-bimolecular reaction

$$k = \frac{1}{t} \cdot \frac{a}{a(a-x)}$$

and Schütz's law $x = k\ \mathrm{pt}$,
and obtained the following equation;

$$k = \frac{1}{t^{k'}} \cdot \frac{a}{a(a-x)}$$

By the experiments and calculation according to the equation, the author was able to discuss and conclude as follows.

(1) By the method of least squares, the two constants k and k' of the above equation were calculated from the experimental data of trypsin and pepsin. The calculated values coincide very well with the experiments. This fact shows the correctness of the author's equation. That is, the decomposition of the proteins of brewing barley by trypsin and pepsin was expressed by the author's equation very well.

(2) In the case of trypsin, if k' is taken as the abscissa, and log k as the ordinates, the proteins soluble in 10% NaCl solution, in 70% alcohol, and in 0.2% NaOH solution make three straight lines respectively. Therefore, the relation between k and k' has to be expressed by the equation.

$$\log k = mk' + b.$$

The two constants of the straight line were calculated by the method of least squares. The two intersections of the three straight lines were

calculated as follows; (0.5309, −3.81421) and (0.9495, −4.97407).

(3) That the intersection were obtained shows that the three proteins, at least those in the barley, have some continuous constitution. It also seems that the three proteins gradually merge with each other either qualitatively or qantitatively taking as the limit the proteins whose decompositions are expressed by the curves made by the intersections.

According to the solubility of the proteins in the 10% NaCl solution, in the 70% alcohol or in the 0.2% NaOH solution, no proteins exceed the author's so-called limiting proteins. These facts which seem to prove the the author's opinion concerning the constitution of the proteins deserve careful attention.

(4) The values of k seem to have some relation with the iso-electric point of the proteins. k seems to increase according to the increase of the PH value of the iso-electric point of the point of the proteins.

(5) The values of k' at the intersections of the three straight lines were 0.5309 and 0.9495 which approximate 0.5 and 1.0. If it as 0.5, the equation take on the form of Schütz's law, and if 1.0, the equation become like the form of the bimolecular reaction. Many investigators have already proved the correctness of Schütz's law or the bimolecular equation. Thus it seems that the investigators had limited their results to a specific protein or to the author's limiting proteins. Therefore, the author's limiting proteins had to resemble, at least on the relation to the action of the enzyme, the typical and the representative proteins investigated up to recent days. To expect a general constitution between the two kinds of proteins seems to be the most proper.

ON THE INFLUENCE OF MAGNESIUM-AND MANGAN-SALTS' ALCOHOLIC SOLUTIONS UPON THE INDICATOR PHENOLPHTHALEIN.

By ETSUO TAKAMIYA.

(Received July 5th., 1927.)

I reported the fact in the preceding paper "Experimental studies upon the alkalimetric estimation of amino acids and peptides by the method of Willstätter and Waldschmidt-Leitz" in this journal that Mg-chloride, Mg-sulphate, Mg-nitrate, Mn-chloride and Mn-sulphate behave as acid against

phenolphthalein in their alcoholic solutions.

Further studies on this problem resulted as follows.

1). This phenomenon is entirely due to the influence of these salts upon the indicator, phenolphthalein, in the presence of alcohols.

2). From the fact that this phenomenon occurs also in the case of thymolphthalein as well as of phenolphthalein, I suppose that the cause of this phenomenon is probably due to phthalein-group.

3). The degree of the influence of these salts upon phenolphthalein varies according to the concentration of alcohol.

4). At a definite concentration of alcohol the degree of the influence is proportional to a quantity of these salts present.

(Biochemical Laboratory, Department of Agriculture,
Kyushu Imperial University, Fukuoka.)

RESEARCH ON THE ELECTROLYTIC REDUCTION POTENTIALS OF ORGANIC COMPOUNDS.

PART III. REDUCTION POTENTIALS OF NICOTINIC ACID.

By Masuzo Shikata and Isamu Tachi.

(Received Aug. 26th., 1927.)

Summary of the result:

(1) The reduction potential of nicotinic acid was measured with the dropping mercury cathode and the polarograph.

(2) Two stages of the reduction process were observed.

(3) For the first stage of reduction, observed R-P. was compared with the theoretical value calculated by the following formula at 15°C.,

$$\pi = -\frac{0.05713}{2}\log\frac{k'}{[H^{\cdot}]^2\, C_{C_5H_4N\cdot COOH}}$$

in which by taking the R. P. of 0.01 mol nicotinic acid in (0.01n HCl+ 0.1n KCl) solution, i. e. -0.984V as a standard, we have

$$\log k = 28.33$$

In an acidic as well as in a neutral salt solution, the observed R. P. showed satisfactory concordance with the calculated values, and thus the first stage has been concluded to be the reduction of the carbonyl group of nicotinic acid to aldehyde.

(4) The second stage of reduction is considered to be the reduction

of pyridine ring of nicotinic acid, by comparison with the R. P. of pyridine in our preceding paper.

(5) The reduction of nicotinic acid in an excess of alkali, does not take place, owing, perhaps, to the desorption of negatively charged nicotinic acid ions to the polarised mercury cathode. R. P. in a sodium acetate or sodium bicarbonate solution was about 0.02V more negative than the calculated value.

(6) Maximum of current voltage curve was observed in sodium bicarbonate solution, in which the potential of maximum current intensity was almost independent of the concentration of nicotinic acid.

(7) The reduction potential of benzoic acid was studied for the sake of comparison, with the result that in hydrochloric acid, no reduction but only the deposition of hydrogen ion has been seen, while a potassium chloride solution the R. P. is over 0.240V negative than that of nicotinic acid. Thus the group effect of a carbonyl group is considered to be more effective than a benzene ring.

(8) The decisive conclusion as to the reduction process has been left out for the time, when the isolation of the reduction product, now under investigation, would be completed.

THE POLAROGRAPHIC STUDIES ON THE FERMENTATION PRODUCTS. PART 1.

By KENJIRO SHOJI.

(Received Aug. 31st, 1927.)

Summary of results.

(1) The polarographic method has been applied as the qualitative as well as the quantitative microanalysis on the studies of reducible compounds in the fermentation products, such as "sake" (japanese rice wine), "shoyu" (soya bean sauce), wine, beer and commercial alcohol.

(2) For the "sake," we have found five reducible compounds, which are distinguishable by this method, from the reduction potentials and the saturation curves of polarograms.

They are

	Reduction potential in 0.1 n NH_4Cl from N calomel electrode
Compound I	—0.22 V
Compound II	—0.40 V

Compound III	−0.90 V
Compound IV	−1.33 V
Compound V	−1.63 V

The reduction potentials of reducible substances possibly present in the sake are measured

Cinnamic aldehyde	0.001%	−0.913 V in 0.1 n NH_4Cl
Furfural	0.001%	−1.302 V in 0.1 n NH_4Cl
Acetaldehyde	0.001%	−1.603 V in 0.1 n NH_4Cl

Compound IV and V are found in the distillate (80°–100°C), while componnd I and II are observed in the residual solution after distillation; compound III is found in both cases. Thus it is concluded that the compound III corresponds to the aromatic aldehyde, most probably cinnamic aldehyde or benzaldehyde, compound IV to be furfural, compound V to be aliphatic aldehyde, most probably acetaldehyde.

(3) In "shoyu", compound I, II, III, IV and V are found, in which compound II is much conspicuous than all the other cases.

(4) In wine, five compounds are also found; but except comp-II, the waves are smaller than in the case of "sake".

(5) With respect to reducible compounds, beer is much simpler, and comp-III, IV and V only are recognisable, but not comp-I and II.

(6) In the commercial alcohol, reducible substance are also found, although much less in quantity, so it has been suggested, that this method can probably useful as one of the criterion for the purity of alcohol.

(7) Consideration has been given for the quantitative analysis of acetaldehyde.

(8) Thus the polarographic method has proved to be of much applicable for the studies of the fermentation products, although this method is by no means the decisive identification of the reducible substances.

(In the Agricultural Chemical Laboratory,
Faculty of Agriculture, Kyoto Imperial University.)

ON THE CHEMICAL CONSTITUENTS OF YEAST-EXTRACT.

By Dr. SATOR OHDAKE.

Tokyo Imperial University.

(Received in August 27th., 1927)

The present communication deals with the chemical studies on the nitrogenous constituents of the yeast extract for the purpose of isolating the antineuritic substance in pure state. When the alcoholic extract of yeast is treated with a concentrated tannin solution, a precipitate is formed, which carries down a greater part of the active substance together with many other impurities. This tannin precipitate is dissolved in dilute acetone, decomposed with baryta water and filtered. When the filtrate is evaporated in vacuum after removing the excess of baryta, a brown resinous mass "tannin fraction" which possesses a strong antineuritic power, is obtained.

So, the author has started his studies with a large quantity of this tannin fraction, which was supplied from the Sankyo Company, Ltd., Tokyo, where "Oryzanin" or "Vitamin-B" -preparation is manufactured in large scale since 1912, under the supervision of Prof. Suzuki.

The tannin fraction was now separated into five fractions according to the method described below. The first four fractions (I--IV) were almost free from the antineuritic power, but the fifth one "Oryzanin fraction" was found to be highly active. The first four fractions were investigated thoroughly and the following substances were isolated in pure state, using 30,000kgs. of the pressed yeast as the material.

Adenyl-thiomethyl-pentose, $C_{11}H_{15}N_5SO_3$	480.0g.
Thioamino-Acid, $C_5H_{11}NSO_2$	0.6g,
Adenin	206.0g.
Hypoxanthin	31.8g.
Cholin	15.4g.
Nicotinic acid	26.0g.
Tyrosin	0.3g.
Leucin	25.8g.
Thymin	9.0g.
Unknown base. I. $C_3H_6N_2$	2.0g.
Unknown base. II. $C_6H_8N_2O$	21.0g.

Of these, Adenylthiomethyl-pentose[1] was discovered three years ago

1) U. Suzuki, S. Ohdake and T. Mori:- Journ. Agric. Chem. Soc. Japan, Vol I, No. 2, p. 127—136, 1924; Biochem. Zeits. B. 154. H. 3—6, S. 278—289, 1924.
U. Suzuki and T. Mori:- Journ. Agric. Chem. Soc. Japan. Vol. I, No. 9, p. 653—661, 1925; Biochem. Zeit, B. 162. H. 3—6, S. 413—424, 1925.

by the author in association with U. Suzuki and T. Mori. The second sulphur-compound, thio-amino-acid,[1] was isolated by the author two years ago and was proved to be identical with the sulphur-compound isolated by J. H. Müller[2] from the hydrolytic products of proteins. Nicotinic acid and Thymin were described by C. Funk.[3]

The constitution of the bases (I), $C_3H_6N_2$ and (II), $C_6H_8N_2O$ has not yet settled, but it was proved that they have no antineuritic power. Quite recently, a base having the formula $C_6H_{10}N_2O$ was isolated by Jansen and Donath[4] from rice polishings and according to them, it possesses a strong antineuritic property. This compound is quite like the author's Base II and the difference between them is that the melting point of the hydro-chloride of the Base II is somewhat lower than that of the former and also no diazo-reaction with the Base II.

The fifth fraction "Oryzanin fraction" is now under investigation and the author hopes to be able to publish his further report in near future.

Experimental.

Fresh beer yeast, obtained from a brewery, was macerated several times with cold water, filtered with cloth, centrifuged, and pressed. The pressed yeast retaining still about 80% of water was then added with strong alcohol as much as to make alcoholic content 80% by volume, and after continual stirring for about 40 hours at room temperature, the mixture was pressed and filtered. The residue was once more extracted with 80% alcohol in the same manner. The united alcoholic extract was concentrated to a small volume. After removing the soluble matter by shaking with ether the light brown aqueous solution was further evaporated in vacuum to a syrupy consistence. In this way, the "alcoholic extract" containing about 20% of water was obtained. The yield was about 2.5% of the pressed yeast and its curative doses for pigeon was found to be 0.1—0.2g. per day.

The alcoholic extract thus prepared was now dissolved in twice of its volume of water and treated with a 20% aqueous solution of tannic acid, until no-more precipitate was produced. The voluminous precipitate thus obtained was now dissolved in dilute acetone, decomposed with baryta water and filtered. The filtrate freed from an excess of baryta was evaporated in vacuum to a small volume. On keeping for several days in a cool place,

1) S. Ohdake:- Journ. Agric. Chem. Soc. Japan. Vol. I, No. 8, 1925. Biochem. Zeits. B. 161, H. 4—6. 1925. Journ. Agric. Chem. Soc. Japan. Vol. II, No. 10, 1926.
2) J. H. Muller:- Journ. Bact. VII. 309—325, 1922. Journ. Biol. Chem. LVI. No. 1, 1923.
3) C. Funk:- Journ. Physiol. 43. 395, 1911. Journ. Physiol. 45, 75, 1912. Journ. Physiol. 46, 173, 1913.
4) B. C. P. Jansen and W. F. Donath:- Report of Med.-Labor. Weltevreden, Java, 1927.

spherical crystals separated out, which were collected, washed with a little cold water and dried; ……*"Fraction I." The yield from 30,000 kgs. of pressed yeast amounted to 180g.*

The mother liquor of the fraction (I) was again added with so much strong alcohol as to make its concentration of the solution about 80% by volume. A voluminous precipitate formed thereby was settled by keeping in a cool place, filtered by suction, washed with a small volume of 80% alcohol and dried. 120g. of brownish powder were thus obtained; ……"Fraction II."

The filtrate of the fraction (II) was concentrated in vacuum to a small volume and acetone was added as much as to make its content 50% by volume. The precipitate fromed thereby was filtered, washed carefully with dilute acetone and dried over sulphuric acid. About 130 gs. of a brown mass were obtained; ……"Fraction III."

The filtrate of the fraction (III.) was again evaporated in vacuum to a small volume and treated with absolute acetone. Whereby a greater part was thrown down as a brown resinous mass which possessed strong antineuritic property. It was dissolved in a small volume of water and evaporated in vacuum to a syrupy consistence containing about 15% of water. The curative dose of this fraction for pigeon was 0.01—0.015 per day. The yield was about 5% of the "alcoholic extract" or 0.125% of the original pressed yeast. To this fraction, the name "crude oryzanin" was given. The supernatant acetone solution displaying a light brown color was now concentrated in vaccum and 2,800 g. of dark brown syrup were obtained. It consisted chiefly of organic bases and resinous matter; ……"Fraciion IV."

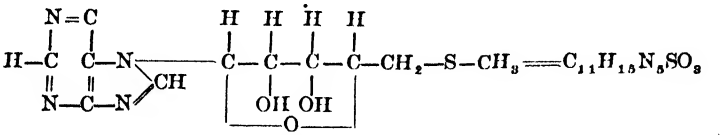
The author carried out thorough investigation on each fraction mentioned above and the results are described in the present communication. The "oryzanin-fraction" is now under examination, so it will be reported in the later opportunity.

Fraction I.

The crude product designated as "Fraction I." was repeatedly crystallized from hot water and 70 g. of fine glistening colorless prisms were obtained, which were identified as adenylthiomethyl-pentose.

1) Adenylthiomethyl-pentose:- It melts at 209 - 210°C. (Uncorr), and is readily soluble in hot water, but insoluble in alcohol and ether. Its specific rotatory power is: $[\alpha]_D^{17} = +20.1°$, in 10% hydrochloric acid solution. It gives white precipitate with phosphotungstic acid or with phosphomolybdic acid. It gives also Kossel's and Bial's reactions as well as ferri-ferricyanide reaction. The sulphur in this compound is detectable either by sodium-nitroprusside or by lead acetate after boiling with strong alkali.

The analysis of the free base as well as of its picrate proved it to be a new sulphur-compound, having the empirical formulae $C_{11}H_{15}N_5SO_4$. When boiled with dilute acid, it is easily hydrolysed into adenin $C_5H_5N_5$ and a new thiosugar $C_6H_{12}SO_4$. Further studies showed its structure to be as follows:-[1]



From the mother liquor of adenylthiomethyl pentose about 30g. of potassium sulphate were obtained.

Fraction II.

The "Fraction II" was dissolved in hot water, decolorized with charcoal, and while hot, about three times of its volume of absolute alcohol were added. Upon standing, fine spherical crystals separated, which after recrystallization from dilute alcohol, formed glistening colorless plates, melting at 285—287°C (Uncorr.) with decomposition. Yield: 15g.

[A] This compound resembled in its properties to leucin but it contained sulphur which was detectable either by sodium nitroprusside or by lead acetate after fusing with metallic sodium. Further studies showes it to be a mixture of leucin and a sulphur compound which were very difficult to separate each other by fractional crystallization. So it was dissolved in 300c.c. of water and treated with a hot saturated solution of mercuric chloride, whereby the sulphur compound alone, was precipitated leaving leucin in the solution.

2) Thioamino-acid $C_5H_{11}NSO_2$:- The white precipitate, obtained as above, was collected after standing over night and decomposed with hydrogen sulphide. The filtrate of mercury sulphide gave on evaporation, colorless crystals which were recrystallized from dilute alcohol. Yield: 0.6g.

It forms colorless, thin monoclinic plates melting at 271—272°C. (Uncorr.) with decomposition. It is readily soluble in water and dilute alcohol, but insoluble in ether, benzene, etc. Its specific rotatory power is $[\alpha]_D^{16} = -11.77°$ in aqueous solution.

The empirical formula of this compound was proved to be $C_5H_{11}SNO_2$. It forms copper-salt $Cu(C_5H_{10}SNO_2)_2$, crystallizing in light blue thin monoclinic plates. The derivative of α-naphtylisocyanate $C_{16}H_{18}N_2SO_3$ crystallizes in white long needles, melting at 187°C. (Uncorr.) Further the β-naphtalene-sulpho-derivative ($C_{15}H_{17}S_2NO_4$) was prepared which crystallizes in white

1) U. Suzuki, S. Ohdake and T. Mori:- Journ. Agri. Chem. Soc. Japan. Vol. I, No. 2, 1924. Biochem. Zeits. B. 154, H. 3—6, 1924. U. Suzuki and T. Mori:- Journ. Agri. Chem. Soc. Japan. Vol. I, No. 9, 1925 Biochem. Zeits. B. 162, H. 3—6, 1925.

needles and melts at 204°C. (Uncorr.)

An aqueous solution of thioamino-acid gives a violet coloration with ninhydrin on warming, while Millon's, Folin's and biuret-reactions are all negative. With mercuric chloride, mercuric nitrate and mercuric sulphate, it gives a white precipitate, but it gives no precipitate either with phospho-tungstic acid or with picric acid. Even a boiling strong alkali does not split sulphur from this compound. The nitroprusside and the lead-acetate reactions are only given when it is fused with metallic sodium. In contrary to ethyl-cystein, it is quite stable toward boiling strong alkali, giving neither ammonia nor ethylmercaptane.

From these properties, this compound was assumed to be a thioamino-acid having the formula C_3H_7S-$CHNH_2COOH$.[1] Recently J. H. Müller[2] isolated a sulphur-compound $C_5H_{11}SNO_2$ from hydrolytic products of casein. For the purpose of comparing these two compounds the present author prepared the same sulphur-compound from casein according to the Müller's mercuric method, and confirmed that it is identical with the thioamino-acid isolated from yeast-extract in all respect, except that the specific rotatory power of the former was little lower than the latter. It was found afterwards that, the Müller's compound was partially racemized during the extraction with hot baryta-water.

The author also isolated the same thioamino-acid from the hydrolytic product of yeast-protein by the same treatment, so its presence in the yeast extract might be due to the autolysis of yeast itself. As this compound was isolated, further, from egg-albumin, blood-fibrin and from the protein of rice-bran etc, it must be an important constituent of various protein.[3]

3) Leucin :- The filtrate from the mercuric precipitate of thioamino-acid was treated with hydrogen sulphide and evaporated in vacuum. The residue was dissolved in hot-water and treated with freshly prepared silver oxide to remove hydrochloric acid. The precipitate was filtered off and the filtrate was treated with hydrogen sulphide to remove the excess of silver and evaporated to a small volume. By adding twice of its volume of alcohol, leucin crystallized out forming glistening colorless thin plates which was recrystallized from hot dilute alcohol. Yield : 10.5g.

It melts and decomposes at 289—290°C (Uncorr.) in a sealed tube. It was dried at 100°C. in vacuo and analysed.

1) S. Ohdake :- Journ. Agric. Chem. Soc. Japan. Vol. I, No. 8, 1925. Biochem. Zeits. B. 161, H. 4—6, 1925.
2) J. H. Müller :- Journ. Bact. VII. 309—325, 1922. Journ. Biol. Chem. LVI. No. 1, 1923.
3) S. Ohdake :- Journ. Agric. Chem. Soc. Japan. Vol. II, No. 10, 1926.

a) Nitrogen :-

No.	Subst. mg.	Vol. of N. c c.	Temp. c.	Atmosph-Press. m.m.	N %
1	80.0	7.3	16	763	10.68

b) Carbon and hydrogen :-

No.	Subst. mg.	CO_2 mg.	H_2O mg.	C %	H %
2	174.6	350.6	158.8	54.75	10.08

Found	C%	H%	N%
1)	54.75	10.08	10.68
Calc. for $C_6H_{12}NO_2$	54.97	9.99	10.69

[B] The filtrate from the mixture of the thioamino-acid and leucin was concentrated to about 500c.c., and precipitated with phosphotungstic acid. The precipitate was then decomposed with baryta. The filtrate of barium tungstate was evaporated to a small volume after removing the exess of baryta, and treated with an aqueous solution of silver nitrate.

(a) The precipitate thus obtained, was distributed in a little water and treated with ammonia. After standing over night, the silver precipitate was collected, suspended in water and decomposed with hydrogen sulphide. The filtrate from silver sulphide was concentrated to a small volume, made alkaline with ammonia and kept in a cold place when adenin separated out as fine crystals. It was recrystallized from hot water. Yield : 2.8g.

4) Adenin :- It forms microscopic short, white needles, sparingly soluble in water. Heated in a capillary, it darkens at 280°C. (Uncorr.) It gives Kossel's adenin reaction while Weidel's ; Xanthin and diazo-reaction are all negative. It was dried at 100°C. in vacuo and analysed :-

Nitrogen :-

No.	Subst. mg.	Vol. of N. c.c.	Vol.-Correction. c.c.	Temp. C.	Atmosph-Press. mm.	N %
1	2.035	0.867	0.915—2Vol%	16	762	52.20
Calculated for ..... $C_5H_5N_5$						51.85

Adenin picrate :- It crystallizes in long yellow needles, sparingly soluble in water.

Analysis of the picrate :-

Nitrogen :

No.	Subst. mg.	Vol. of N. c c.	Vol.-Correction. c c.	Temp. C	Atmosph-Press. mm.	N %
1	2.49	0 652	0.665—2Vol%	16	756	30.76
Calculated for ..... $C_5H_5N_5$-$C_6H_3N_3O_7$						30.79

5) Hypoxanthin picrate :- When the mother liquor of adenin, was concentrated, neutralised with hydrochloric acid, and treated with natrium picrate, the crystals of hypoxanthin picrate were obtained. They were washed

with acetone and recrystallized from hot alcohol. Yield: 0.15g.

It forms light yellow, thick plates, melting at 247°C (Uncorr.), readily soluble in hot water, but insoluble in ether and benzene.

Microanalysis after Pregl:–

a) Nitrogen:–

No.	Subst mg.	Vol. of N. c c.	Vol.–Correction. c.c.	Temp. C.	Atmosph–Prese. mm.	N %
1	3.82	0.843	0.86—2Vol%	17	770	26.32
2	5.17	1.137	1.16—2Vol%	16	770	26.49

b) Carbon and hydrogen:

No.	Subst. mg.	CO_2 mg.	H_2O mg.	C %	H %
3	8.58	11.52	1.64	36.62	2.12

Found/by Pregl's micro–analysis.	C%	H%	N%
1)	36.62	2.12	26 32
2)	—	—	26.49
Calculated for $C_5H_4N_4O$–$C_6H_3N_3O_7$	36.44	1.92	26.85

(b) The filtrate from the silver–precipitate (a) was freed from silver by means of hydrogen sulphide and evaporated in vacuum to expell off the ammonia and hydrogen sulphide, sulphuric acid was added to the extent of 5% of the solution and precipitated with phosphotungstic acid. The precipitate was decomposed with baryta in usual way and after removing the excess of baryta with sulphuric acid, the solution was concentrated in vacuum to a small volume whereby adenin nicotinate separated out as the aggregates of white needles.

6) Adenin nicotinate:– The crude product was recrystallized from hot water. Yield: 1g.

It forms white needles, aggregated in stelli–form, readily soluble in hot water, but sparingly in cold–water. It melts at 210—230°C. (Uncorr.) It gives Kossel's adenin reaction, while Xanthin, Weidel's and sulphur reactions are all negative.

From these properties this compound was assumed to be a salt of adenin and a substance of acidic nature. For the purpose of separating adenin from this compound, the latter was converted into picrates and subjected to fractional crystallization, whereby adenin picrate separated first from the aqueous solution, forming a long yellow needles. It was dried at 100°C in vacuo, and analysed.

Adenin picrate:–

Nitrogen:–

No.	Subst. mg.	Vol. of N. c c.	Vol.–Correction. c.c.	Temp. C.	Atmosph–Press. mm.	N %
1	3.03	0.789	0.805—2Vol%	17	764	30.81
Calculated for $C_5H_5N_5$–$C_6H_3N_3O_7$						30.79

Picrate of nicotinic acid – The filtrate of adenin picrate gave on further concentration the picrate of nicotinic acid which was recrystallized from hot alcohol. Yield : 0.15g.

It forms light yellow thick plates, melting at 219°C (Uncorr.) Dried at 100°C. in vacuum and analysed.

Nitrogen –

No	Subst mg.	Vol of N c c.	Vol -Correction c c	Temp C	Atmosph-Press mm	N %
1	3 125	0 427	0 436—2Vol%	18 5	754	15 89
Calculated for			$C_5H_4N(CO_2H-C_6H_3N_3O_7$			15 91

The above figure agrees with the picrate of nicotinic acid, so the compound described under (6) was adenin nicotinate.

(c) The filtrate of the fraction (a), was treated with silver nitrate and baryta water. The precipitate formed thereby was suspended in water, decomposed with hydrogen sulphide and evaporated in vacuum. Sulphuric acid was added to the extent of 5% of the solution and precipitated with phosphotungstic acid. The precipitate was decomposed with baryta in usual way and concentrated in vacuo to a small volume. By adding picric acid a picrate of unknown base separated out as yellow plates which were filtered and recrystallized from dilute alcohol. Yield : 0 05g.

7) Picrate of unknown base. ($C_{11}H_8N_2O$) – Glistening light yellow plates, readily soluble in hot water and alcohol, but sparingly soluble in cold water, melts sharply at 192°C. (Uncorr.) without decompositon. After drying at 100°C in vacuo, it was analysed.

a) Nitrogen :–

No	Subst mg	Vol of N c c	Vol -Correction c c	Temp C	Atmosph-Press mm	N %
1	4 215	0 6566	0 67—2Vol%	17	767	18 50
2	4 465	0 7105	0 725–2Vol%	17	767	18 90

b) Carbon and hydrogen .–

No	Subst mg	CO_2 mg	H_2O mg	C %	H %
3	7 14	10 80	1 84	41 25	2 86
4	7 20	10 93	1 89	41 40	2 92

Found/by Pregl's micro-method	C%	H%	N%
1) ..	41 25	2 86	18 50
2)	41 40	2 92	18 90
Calculated for $C_6H_8N_2O$-$C_6H_3N_3O_7$	40.79	3 11	19 83

Unfortunately, the material was not sufficient for further study but judged from its properties, it is probably the same compound with the base (No. 27).

8) Picrate of adenylthiomethyl–pentose :– The filtrate from the above picrate (7), gave on further concentration another picrate consisting of light

yellow plates, which after recrystallization from dilute alcohol, weighed 0.18g.

It melts at 165°C (Uncorr.) and gives strong sulphur reaction. Dried at 100°C in vacuo, and analysed.

a) Nitrogen :–

No.	Subst. mg.	Vol. of N. c.c.	Vol.-Correction. c.c.	Temp. C.	Atmosph-Press. mm.	N %
1	4.600	0.8085	0.825–2Vol%	16	768	20.98
2	4.355	0.7595	0.775-2Vol%	16	768	20.81
3	3.11	0.5437	0.565–2Vol%	14	762	20.85
4	3.54	0.6076	0.620-2Vol%	14	764	20.52

b) Carbon and hydrogen :–

No.	Subst. mg.	CO_2 mg.	H_2O mg.	C %	H %
5	7.575	10.67	2.61	38.54	3.83
6	7.170	10.05	2.42	38.23	3.75
7	7.30	10.04	2.47	37.51	3.75
8	7.36	10.19	2.31	37.76	3.49

Found/by Pregl's micro-method.	C %	H %	N %	S %
1)	38.54	3.83	20.98	—
2)	38.23	3.75	20.81	—
3)	37.51	3.75	20.85	—
4)	37.76	3.49	20.52	—
Calculated for $C_{11}H_{15}N_5SO_3$–$C_6H_3N_3O_7$	38.78	3.42	21.29	6.08

The analysis agrees thus with the picrate of adenylthiomethyl–pentose.

(d) The filtrate from the fraction (c), was freed from silver and baryta by treating with hydrochloric and sulphuric acids, and precipitated with phosphotungstic acid. The precipitate thus formed was decomposed with baryta water. The filtrate, containing the free base was freed from baryta by sulphuric acid, concentrated in vacuo to a small volume and picric acid was added to it. On cooling cholin picrate separated out, which were recrystallized from hot dilute alcohol. Yield : 2.5g.

9) Cholin picrate :– Light yellow macroscopic prisms, readily soluble in water and melts at 245°C (Uncorr.). Dried at 100°C in vacuo and analysed :

Nitrogen :–

No.	Subst. mg.	Vol. of N. c.c.	Vol.-Correction. c c.	Temp. C.	Atmosph-Press. mm.	N %
1	6.02	0.823	0.84—2Vol%	17	761	16.11
2	5.43	0.745	0.76—2Vol%	17	755	16 04
Calculated for $C_5H_{15}NO_2$–$C_6H_2(NO_2)_3OH$						16.00

The above result agrees fairly with cholin picrate.

Chloro–aurate of cholin :– The chloro–aurate was prepared from the picrate. It forms characteristic orange needles, melting at 249°C (Uncorr.).

Dried at 100°C in vacuo and analysed:

a) Nitrogen :–

No.	Subst. mg.	Vol. of N. c c.	Vol.-Correction. c.c.	Temp. C.	Atmosph-Press. mm.	N %
1	8.46	0.235	0.24—2Vol%	16	760	3.28
2	7.43	0.198	0.202-2Vol%	16	760	3.15

b) Carbon and hydrogen :–

No.	Subst. mg.	CO_2 mg.	H_2 mg.	Au mg.	C %	H %	Au %
3	9.11	4.56	2.89	4.035	13.65	3.52	44.29

Found/by Pregl's micro-method	C %	H %	N %	Au %
1)	13.65	3.52	3.28	44.29
2)	—	—	3.15	—
Calculated for… $C_5H_{14}NOCl\ AuCl_3$	13.54	3.16	3.16	44.47

[C.] The filtrate from phosphotungstic precipitate [B], was treated with a slight excess of baryta and filtered. The filtrate was freed from an excess of baryta and concentrated in vacuo to a small volume, upon standing white crystals of tyrosin separated out. They were recrystallized from hot water. Yield: 0.3g.

10) Tyrosin :– Long white needles, sparingly soluble in water. Gives an intense coloration with Millon's reagent and with ninhydrin. Dried at 100°C in vacuo and analysed :–

Nitrogen :–

No.	Subst. mg.	Vol. of N. c.c.	Vol -Correction. c.c.	Temp. C.	Atmosph-Press. mm.	N %
1	5.43	0.363	0.37—2Vol%	19	760	7.81
2	8.15	0.539	0.55—2Vol%	19	760	7.73
Calculated for… $C_6H_4(OH)C_2H_3NH_2COOH$						7.74

11) Leucin :– The filtrate from tyrosin gave on further concentration 10.5g. of pure leucin.

It forms glistening plates, and decomposes at 289—293°C. (Uncorr.). Dried at 100°C in vacuo and analysed :–

a) Nitrogen :–

No.	Subst. mg.	Vol. of N. c c.	Nol.-Cosrection. c.c.	Temp. C.	Atmosph-Press. mm.	N %
1	7.33	0.666	0.68—2Vol%	17	760	10.69

b) Carbon and hydrogen :–

No.	Subst. mg.	CO_2 mg.	H_2O mg.	C %	H %
2	8.73	17.53	7.90	54.76	10.05

Found/by Pregl's micro-method.	C %	H %	N %
1)	54.76	10.05	10.69
Calculated for… $C_6H_{13}NO_2$	54.97	9.99	10.69

Fraction III.

The fraction III obtained by treating with 50% acetone, weighed about 130g. when washed with a small volume of 50% acetone and dried. It was dissolved in hot water, decolorized with charcoal, and the colorless crystals separating out on cooling, were recrystallized from hot water 80g. of pure adenylthiomethyl-pentose ($C_{11}H_{15}N_5SO_3$) were thus obtained.

12) Adenylthiomethyl-pentose :- Colorless prisms with silky lustre, melting at 209—210°C (Uncorr.) without decomposition, readily soluble in water, gives Kossel's, Bial's and sulphur reactions etc. Boiled with diluted acid, it is easily hydrolysed into adenin ($C_5H_5N_5$) and a thio-sugar ($C_6H_{12}SO_4$).[1]

The mother liquor of adenylthiomethyl-pentose gave on further evaporation nothing but potassium sulphate.

Fraction IV.

The brown syrup, fraction IV, gave after long keeping in a cool-place, spherical crystals of adenylthiomethyl-pentose. The yield of the crude product was about 400g. After recrystallization from hot-water, 310g. of pure adenylthiomethylpentose melting at 209—210°C (Uncorr.) were obtained.

13) Adenylthiomethyl-pentose :- As has already been mentioned, it gave, in addition to Kossel's adenin reaction and Bial's pentose reaction etc. an intensive sulphur reaction and was readily hydrolysed into adenin and a thio-sugar by boiling with dilute acid.

Concentrating further the filtrate from adenylthiomethylpentose, about 2.400g. of a syrup were obtained. It was dissolved in about eight times of its volume of hot water. The resinous substance separating on cooling was filtered off, and the filtrate was treated with basic lead acetate.

[A] The lead acetate precipitate was decomposed with hydrogen sulphide. The filtrate from lead sulphide was evaporated in vacuo and a dark-brown resinous mass was obtained. It was sparingly soluble in water but readily soluble in alcohol, acetone and alkalies. The same resinous substance was found always accompanied in every fractions coming next.

The filtrate of lead acetate precipitate was treated with sulphuric acid to remove the excess of lead and a 50% aqueous solution of phosphotungstic acid was added to it.

[B] The phosphotungstic acid precipitate was decomposed with baryta water in usual way and concentrated in vacuo to a small volume. On cooling,

1) U. Suzuki, S. Ohdake and T. Mori :- Journ Agric. Chem. Soc of Japan. Vol. I, No. 2, 1924. Biochem. Zeits. B. 154, Heft. 3—6, 1924. U. Suzuki and T. Mori :- Journ. Agric. Chem. Soc. of Japan. Vol. I, No. 9, 1925. Biochem. Zeits. B. 162. H. 3—6, 1925.

fine crystals of adenin separated out, which were recrystallized from hot-water. Yield: 75g.

14) White short needles, sparingly soluble in water, gives Kossel's adenin reaction, while Weidel's and Xanthin reactions etc. are all absent. Its picrate crystallizes in characteristic long yellow needles, sparinlgy soluble in water.

Dried at 100°C in vacuo and analysed:-

a) Nitrogen:-

No.	Subst. mg.	Vol. of N. c c.	Vol.-Correction. c.c.	Temp. C.	Atmosph-Press. mm.	N %
1	2.06	0.921	0.94—2Vol%	18	754	52.03

b) Carbon and hydrogen:-

No.	Subst. mg.	CO_2 mg.	H_2O mg.	C %	H %
2	7.25	11.74	2.44	44.16	3.74

Found/by Pregl's micro-analysis.	C %	H %	N %
1)	44.16	3.74	52.03
Calculated for $C_5H_5N_5$	44.44	3.71	51.85

(a) The filitrate from adenin crystals was acidified with nitric acid and treated with 20% aqueous solution of silver nitrate. A voluminous precipitate formed, was collected and treated with ammonia to convert it into silver salt. After standing for 15hs., the insoluble silver salt was collected and decomposed with hydrogen sulphide. The filtrate gave on evaporation fine white crystals which were recrystallized from hot water. Yield: 66g.

15) Adenin-Hypoxanthin:- Shrot white needles, melted at 325—327°C (Uncorr.) and unlike adenin, it is readily soluble in hot water with neutral reaction. It gives also Kossel's reaction, but Weidel's, Xanthin- and diazo-reactions are all negative. From these properties, it was assumed to be adenin-hypoxanthin.[1]

Dried at 100°C in vacuo and analysed.

a) Nitrogen:-

No.	Subst. mg.	Vol. of N. c.c.	Vol.-Correction c.c.	Temp. C.	Atmosph-Press. mm.	N %
1	2.25	0.897	0.915-2Vol%	17	759	46.84
2	2.05	0.804	0.82—2Vol%	17	764	46.40

b) Carbon and hydrogen:-

No.	Subst. mg.	CO_2 mg.	H_2O mg.	C %	H %
3	7.90	12.84	2.92	44.33	4.08

1) Bruhs:- Zeits. f. Physiol. Chem. 14. 561. 1890.

Found/by Pregl's microanalysis	C%	H%	N%
1)	44.33	4.08	46.84
2)	—	—	46.40
Calculated for $C_5H_5N_5$-$C_5H_4N_4O$	44.28	3.32	46.50

The above result confirms the first assumption, so it was tried to separate these components by converting it into picrates. For this purpose 4g. of this compound were dissolved in water and treated with a slight excess of picric acid. The picrate of adenin separated first forming characteristic long needles. The yield of the purified picrate was 3g.

Nitrogen :-

No.	Subst. mg.	Vol. of N. c.c.	Vol-Correction. c.c.	Temp. C.	Atmosph-Press. mm.	N %
1	3.00	0.789	0.805-2Vol%	17	760	30.96
Ca'culated for $C_5H_5N_5$-$C_6H_3N_3O_7$						30.79

Hypoxanthin picrate :- The filtrate from adenin picrate was concentrated to a small volume and cooled. The crystals of hypoxanthin picrate separated as light yellow thick plates, melting at 255°C. (Uncorr.) Yield : 2g. Dried at 100°C in vacuo and analysed ;

a) Nitrogen :-

No.	Subst. mg.	Vol. of N. c.c.	Vol-Correction. c c.	Temp. C.	Atmosph-Press. mm.	N %
1	3 97	0.926	0.945-2Vol%	17	760	27.45
2	4 06	0.921	0.94—2Vol%	17	760	26.91
3	3.32	0.735	0.75—2Vol%	18	756	26.72

b) Carbon and hydrogen :-

No.	Subst. mg.	CO_2 mg.	H_2O mg.	C %	H %
4	7.91	10.56	1.77	36.41	2.49
5	7.10	9.47	1.41	36.25	2.21

Found/by Pregl's micro-analysis	C%	H%	N%
1)	36.41	2.49	27.45
2)	36.25	2.21	26.91
3)	—	—	26.72
Calculated for $C_5H_4N_4O$-$C_6H_3N_3O_7$	36.44	1.92	26.85

16) Adenin picrate :- The mother liquor from the adenin-hypoxanthin was evaporated in vacuum to dryness, the residue was dissolved in hot-water and added with picric acid. Upon standing, adenin picrate separated out. After recrystallization from hot dilute alcohol, it weighed 60g.

It forms characteristic long yellow needles, sparingly soluble in water and melts at 290°C. (Uncorr.) with decomposition.

Nitrogen :–

No.	Subst. mg.	Vol. of N. c.c.	Vol-Correction. c.c.	Temp. C.	Atmosph-Press. mm.	N %
1	3.09	0.813	0.83–2Vol%	17	760	30.97
2	2.91	0.764	0.78–2Vol%	17	760	30.90

Calculated for……$C_5H_5N_5$–$C_6H_8N_2O_7$…… …… ……30.79

17) Picrate of adenyl-thiomethyl-pentose :– When the mother liquor of adenin picrate was concentrated further and cooled, the picrate of adenyl-thiomethyl-pentose separated. Recrystallized from dilute alcohol, it formed light yellow thin plates, melting at 165°C. (Uncorr.) Yield : 9g.

a) Nitrogen :–

No.	Subst. mg.	Vol. of N. c.c.	Vol-Correction. c.c.	Temp. C.	Atmosph-Press. mm.	N %
1	3.68	0.671	0.685–2Vol%	17	764	21.57
2	4.66	0.853	0.87—2Vol%	17	756	21.43

b) Sulphur :–

No.	Subst. mg.	$BaSO_4$ mg.	S mg.	S %
3	8.86	3.86	0.53143	6.05

Found/by Pregl's microanalysis	C%	H%	N%	S%
1)……	—	—	21.57	6.05
2)……	—	—	21 43	—
Calculated for …. $C_{11}H_{15}N_5SO_3$–$C_6H_8N_2O_7$	38.78	3.42	21.29	6.08

18) Hyoxanthin picrate :– The mother liquor from the above picrate (17) was further concentrated, the resinous matter thereby separated was removed by filtration. On keeping the filtrate in a cool-place, hypoxanthin picrate crystallized out as fine yellow thick plates which were recrystallized from hot dilute alcohol. Yield : 4.8g. M. p. = 247°C. (Uncorr.)

a) Nitrogen :–

No.	Subst. mg.	Vol. of N. c.c.	Vol-Correction. c c.	Temp. C.	Atmosph-Press. mm.	N %
1	4.08	0.931	0.95–2Vol%	17	760	26.86
2	3.99	0.911	0.93–2Vol%	17	760	27.09

b) Carbon and hydrogen :–

No.	Subst. mg.	CO_2 mg.	H_2O mg.	C %	H %
8	7.50	10.02	1.04	36.44	1.85

Found/by Pregl's microanalysis	C%	H%	N%
1)……	36.44	1.85	26.86
2)……	—	—	27.09
Calculated for ……$C_5H_4N_4O$–$C_6H_8N_2O_7$ ……	36.16	1.92	26.85

(b) The ammoniacal filtrate from the insoluble silver salt (a) already mentioned, was treated with hydrogen sulphide and filtered off the silver

sulphide. To the filtrate baryta water was added in slight excess and evaporated in vacuum to expell off the ammonia, sulphuric acid was added to remove baryta and then precipitated with phosphotungstic acid. A voluminous precipitate formed thereby was decomposed with baryta water. The filtrate, freed from the excess of baryta was evaporated in vacuum to a small volume. Adenin separated as microscopic white crystals.

19) Adenin :– White short needles, sparingly soluble in water, and gives Kossel's adenin reaction but Weidel's, Xanthin-and diazo-reactions are negative. It was converted into picrate and analysed :

Nitrogen :–

No.	Subst. mg.	Vol. of N. c.c.	Vol-Correction. c.c.	Temp. C.	Atmosph-Press. mm.	N %
1	3.12	0.8134	0.83-2Vol%	17	764	30.85
Calculated for $C_5H_5N_5$-$C_6H_3N_3O_7$						30.79

20) Adenin nicotinate :– The filtrate from adenin was concentrated in vacuum to a small bulk. On cooling, the aggregates of white needles were obtained. Yield : 4.2g.

Although this compound gives intensive adenin reaction, yet it is not adenin itself because it dissolves easily in hot water and melts at 209–240°C. (Uncorr.) The analysis gave the following results :–

a) Nitrogen :–

No.	Subst. mg.	Vol. of N. c.c.	Vol-Correction. c c.	Temp. C.	Atmosph-Press. mm.	N %
1	2.06	0.578	0 59-2Vol%	17	754	32.76

b) Carbon and hydrogen :–

No.	Subst. mg.	CO_2 mg.	H_2O mg.	C %	H %
2	7.23	11.51	3.17	54.73	4.87

Found/by Pregl's microanalysis	C%	H%	N%
1)	52.85	4.10	32.76
Calculated for $C_5H_4NCO_2$-$C_5H_5N_5$	51.36	3.50	32.68

From the above results it was assumed to be adenin-nicotinate. To confirm this assumption, it was converted into picrate and subjected to fractional crystallization, whereby adenin-picrate first crystallized out as long yellow needles.

Adenin picrate :–

Nitrogen :–

No.	Subst. mg.	Vol. of N. c c.	Vol-Correction. c.c.	Temp. C.	Atmosph-Press. mm.	N %
1	3.02	0.789	0.805-2Vol%	17	764	30.91
Calculated for $C_5H_5N_5$-$C_6H_3N_3O_7$						30.79

Picrate of nicotinic acid :– The mother liquor of adenin-picrate, concent-

rated to a small volume, gave on cooling the picrate of nicotinic acid. Light yellow, thick plates, M. P.=219°C. (Uncorr.)

Analysis of the picrate :–

a) Nitrogen :–

No.	Subst. mg.	Vol. of N. c.c.	Vol-Correction. c.c.	Temp. C.	Atmosph-Press. mm.	N %
1	3.715	0.51	0.59–2Vol%	17	754	15.69

b) Carbon and hydrogen :–

No.	Subst. mg.	CO_2 mg.	H_2O mg.	C %	H %
2	7.89	11.92	1.75	41.20	2.34

Found/by Pregl's micro-method	C%	H%	N%
1).....	41.20	2.34	15.69
Calculated for $C_5H_4NCO_2H$-$C_6H_3N_3O_7$	41.19	2.27	15.91

From these results the above compound (20) was proved to be adenin-nicotinate.

21) Picrate of nicotinic acid :– To the mother liquor of adenin nicotinate (20), picric acid was added, after a short standing, the picrate of nicotinic acid crystallized out light yellow, thick plates. M. P. 219°C. (Uncorr) Yield : 6g.

Nitrogen :–

No.	Subst. mg.	Vol. of N. c.c.	Vol-Correction. c c.	Temp. C.	Atmosph-Press. mm.	N %
1	3.82	0.514	0.525–2Vol%	17	754	15.71
Calculated for $C_5H_4NCO_2H$-$C_6H_3N_3O_7$						15.91

(c) The filtrate from the purin-fraction (b), was neutralised with $BaCO_3$ and treated with a 20% aqueous solution of silver nitrate. The voluminous precipitate formed was filtered by suction and decomposed with hydrogen sulphide. The filtrate, thus obtained, was evaporated in vacuum to a small volume and after adding sulphuric acid to the extent of 5% of the solution, it was precipitated with phosphotungstic acid.

The precipitate formed thereby decomposed with baryta water and concentrated to a small volume. Upon standing, adenin separated as short white needles. Yield : 18.6g.

22) Adenin :–

a) Nitrogen :–

No.	Subst. mg.	Vol. of N. c.c.	Vol-Correction. c.c.	Temp. C.	Atmosph-Press. mm.	N %
1	2.00	0.887	0.905–2Vol%	17	754	51.79

b) Carbon and hydrogen :–

No.	Subst. mg.	CO_2 mg.	H_2O mg.	CO mg.	C %	H %
2	6.78	10.95	2.29	2.29	44.05	3.82

Found/by Pregl's microanalysis	C%	H%	N%
1)	44.05	3.82	51.79
Calculated for $C_5H_5N_5$	44.44	3.71	51.85

23) Adenin nicotinate :– The filtrate from adenin was further concentrated and left in a cool place when white crystals of adenin nicotinate separated. Yield : 6g. White needles, aggregated in a stelli-form, M. P.=210–240°C (Uncorr.). Unlike adenin, it dissolves easily in hot water with slightly acid reaction, although it gives intensive adenin-reaction.

Nitrogen :–

No.	Subst. mg.	Vol. of N. c.c.	Vol-Correction. c.c.	Temp. C.	Atmosph-Press. mm.	N %
1	2.02	0.568	0.58–2Vol%	17	754	32.83
Calculated for $C_5H_5N_5$–$C_5H_4CO_2$						32.56

Adenin picrate :– The picrate was prepared from the above compound (23) and fractionally crystallized. Adenin picrate first separated as long yellow needles.

Analysis of adenin picrate :–

Nitrogen :–

No.	Subst. mg.	Vol. of N. c.c.	Vol-Correction. c.c.	Temp. C.	Atmosph-Press. mm.	N %
1	3.31	0.862	0.88–2Vol%	17	760	30.65
Calculated for $C_5H_5N_5$–$C_6H_3N_3O_7$						30.79

Picrate of nicotinic acid :– The picrate was obtained from the mother liquor of adenin picrate. M. P.=219°C. (Uncorr.)

Nitrogen :–

No.	Subst. mg.	Vol. of N. c.c.	Vol-Correction. c.c.	Temp. C.	Atmosph-Press. mm.	N %
1	5.03	0.688	0.72–2Vol%	17	761	16.12
Calculated for $C_5H_4NCO_2H$–$C_6H_3N_3O_7$						15.91

The analysis agrees well with the picrate of nicotinic acid.

24) Picrate of adenylthiomethyl-pentose :– The filtrate from adenin-nicotinate (23) was treated with picric acid whereby the picrate of adenylthiomethyl-pentose separated in short yellow needles, which were recrystallized from dilute alcohol. Yield : 30g.

Microanalysis after Pregl :–

a) Nitrogen :–

No.	Subst. mg.	Vol. of N. c.c.	Vol-Correction. c.c.	Temp. C.	Atmosph-Press. mm.	N %
1	4.95	0.965	0.985–2Vol%	17	754	22.76
2	4.09	0.774	0.79–2Vol%	17	764	22.64

b) Carbon and hydrogen :–

No.	Subst. mg.	CO_2 mg.	H_2O mg.	C %	H %
3	7.39	10.45	2.33	38.57	3.50

Found/by Pregl's micro-method	C%	H%	N%	S%
1)	38.57	3.50	22.76	—
2)	—	—	22.64	—
Calculated for $C_{11}H_{15}N_5SO_3$–$C_6H_3N_3O_7$	38.78	3 42	21.29	6.08

25) Picrate of nicotinic acid :– The mother liquor from the preceding picrate (24) was concentrated to a small volume and a slight excess of picric acid was added. On cooling, the picrate of nicotinic acid crystallized out. Yield : 13.2g. M. P.=218° (Uncorr.)

a) Nitrogen :–

No.	Subst. mg.	Vol. of N. c.c.	Vol.–Correction. c.c.	Temp. C.	Atmosph–press. mm.	N %
1	4.95	0.681	0.695—2Vol%	17	761	16.21

b) Carbon and hydrogen :–

No.	Subst. mg.	CO_2 mg.	H_2O mg.	C %	H %
1	8.10	12.37	1.88	41.65	2.58

Found/by Pregl's micro-analysis	C%	H%	N%
1)	41.65	2.58	16.21
Calculated for · $C_5H_4NCO_2$ H–$C_6H_3N_3O_7$	41.19	2.27	15.91

d) The filtrate from the precipitate (c) was treated with an excess of silver nitrate and baryta. The precipitate formed, was decomposed with hydrogen sulphide and filtered. The filtrate was evaporated in vacuum and precipitated again with phosphotungstic acid. A voluminous precipitate was decomposed with baryta water, and filtered. The filtrate freed from an excess of baryta, was evaporated in vacuo to a small volume and picric acid was added. A picrate of unknown base separated in yellow plates which were recrystallized from hot dilute alcohol. Yield : 9.2g.

24) Picrate of unknown base I. ($C_3H_6N_2$) :– Elongated thin plates with light yellow color, readily soluble in hot water but sparingly soluble in cold water, insoluble in ether, benzene etc., melts at 225°C (Uncorr.) followed by decomposition with evolution of gas. Dried at 100°C in vacuo and analysed;

a) Nitrogen :–

No.	Subst. mg.	Vol. of N. c.c.	Vol.–Correction. c.c.	Temp. C.	Atmosph–press. mm.	N %
1	4.27	0.8428	0.86—2Vol%	17	761	23.22
2	4.20	0.8330	0.85—2Vol%	17	765	23.49

b) Carbon and hydrogen :–

No.	Subst. mg.	CO_2 mg.	H_2O mg.	C %	H %
3	7.78	10.74	2.07	37.65	2.96
4	7.41	10.21	2.03	37 58	3.04
5	8.03	10.91	2.06	37.05	2.85

c) Picric acid :-

No.	Subst mg.	Picric acid mg.	Picric acid %
1	200.0	153.06	76.53
2	260.0	200.1	76.96
3	500.0	382.7	76.54

Found	C %	H%	N %	Picric acid.%
1).....	37.65	2.96	23 22	76.53
2).....	37.58	3.04	23.49	76.96
3).....	37.05	2.85	——	76.59
Calculated for .....$C_3H_6N_2$-$C_6H_3N_3O_7$.....	36.12	3.01	23.41	76.59

Hydrochloride of the base :- The hydrochloride was prepared from the purified picrate by dissolving the latter in water and extracting the picric acid, liberated by the addition of hydrochloric acid, with ether. The aqueous solution was concentrated to a small volume and the hydrochloride was precipitated by adding absolute alcohol.

It crystallizes from dilute alcohol in colorless thick plates, readily soluble in water and sparingly soluble in absolute alcohol, melting at 262°C (Uncorr.) with decomposition. It gives white precipitate with phosphotungstic acid, while diazo-, biuret-, millon's and purin-reactions are negative.

Dried at 100°C in vacuo and analysed ;

a) Nitrogen :-

No.	Subst. mg.	Vol. of N. c.c.	Vol.-Correction. c.c.	Temp. C.	Atmosph-press. mm.	N %
1	5 74	1.166	1.19—2Vol%	16	763	24.09
2	5.76	1.166	1.19—2Vol%	16	763	24.00

b) Carbon and hydrogen :-

No.	Subst. mg.	CO_2 mg.	H_2O mg.	C %	H %
3	7.14	8.61	4.44	32.89	6.91
4	7.31	8.78	4.44	32.77	6.75
5	8.41	10.16	4.88	32.95	6.45

Found / by Pregl's micro-method	C %	H%	K %	CL%
1).....	32.89	6.91	24.09	——
2).....	32.77	6.75	24.00	——
3).....	32.95	6.45	——	——
Calculated for ..... $C_3H_6N_2HCL$	33.96	6.60	26.42	33.33

Chloro-platinate of the base :- The chloro-platinate was prepared by adding the alcoholic solution of platinum-chloride to an aqueous solution of

the hydrochloride. Recrystallized from hot water, it forms reddish orange, thick plates, sparingly soluble in water, insoluble in alcohol, and decomposes at 280–285°C (Uncorr.) without melting.

Dried at 100°C in vacuo and analysed;

a) Nitrogen :-

No.	Subst. mg.	Vol. of N. c.c.	Vol.-Correction. c.c.	Temp. C.	Atmosph-press. mm.	N %
1	6.75	0.552	0 563—2Vol%	15	764	9.74
2	6.27	0.529	0.54 —2Vol%	16	767	10.09

b) Carbon and hydrogen :-

No.	Subst. mg.	CO_2 mg.	H_2O mg.	Pt mg.	C %	H %	Pt %
3	9.05	4.47	2.29	3.17	13.47	2.81	35.19
4	8.92	4.43	2.11	3.09	13.54	2.63	34.65
5	8.59	4.13	2 11	2.96	13 08	2.73	34.46

Found / by Pregl's micro-method	C %	H %	N %	Pt %
1)	13.47	2.81	9.74	35.19
2)	13.54	2.63	10.09	34.65
3)	13.08	2 73	——	34.46
Calculated for $(C_3H_6N_2)_2$-H_2PtCl_6	13.16	2.56	10.02	35.65

From these results the free base is considered to be an amine $C_3H_6N_2$, differing in many respects from histidin, arginin, etc. Hoffa[1] once isolated an amine-$C_3H_6N_2$ "Anthracin"- with unknown structure. Whether the present amine is identical with anthracin or not must be investigated later on.

27) Unknown base II. $C_6H_8N_2O$:- The mother liquor from the above picrate (26) was concentrated further and treated with an excess of picric acid. On cooling, a new picrate separated out in a large quantity. It was filtered by suction and recrystallized from dilute alcohol. Yield: 60g.

It crystallizes in yellow, tetragonal thin plates or prisms, melting at 193°C (Uncorr.), readily soluble in hot water, alcohol and glacial acetic acid, but insoluble in benzene, ether etc.

Dried at 80°C in vacuo and analysed :-

a) Nitrogen :-

No.	Subst. mg.	Vol. of N. c.c.	Vol.-Correction c.c.	Temp. C.	Atmosph-press. mm.	N %
1	4.925	0.828	0 845—2Vol%	17	761	19.81
2	4 17	0.686	0.70 — //	17	764	19.46
3	4.44	0.735	0.75 — //	16.5	764	19.62
4*	4.75	0.774	0.79 — //	18	754	18.96
5*	5.04	0.848	0.865— //	18	753	19.55
6**	4.58	0.750	0.765— //	18	755	19.08
7**	4.76	0.797	0.813— //	18	754	19.27

(1) Hoffa, Sitzungsber. d. Phs-Med. Geselschaft, Wurzberg. 1889, 96.

b) Carbon and hydrogen :–

No.	Subst. mg.	CO_2 mg.	H_2O mg.	C %	H %
8	7.54	11.75	2.19	42.50	3.23
9	7.32	11.30	1.92	42.11	2.91
10	7.28	11.45	1.94	42.89	2.96
11**	7.24	11.21	2.10	42.23	3.23

c) Picric acid :–

No.	Subst. mg.	Picric acid mg.	Picric acid %
12	500.0	326.0	65.20
13	500.0	325.8	65.16
14	200.0	130.7	65.35

Found	C %	H%	N %	Picric acid.%
1).....	42.50	3.23	19.81	65.20
2).....	42.11	2.91	19.46	65.16
3).....	42.89	2.96	19.62	65.35
4)* (Purified with glacial acetic acid)	—	—	18.96	—
5)* (" ")	—	—	19.55	—
6)**(Prepared from hydrochloride)	42.23	3.22	19.08	—
7)**(" ")	—	—	19.27	—
Calculated for .....$C_6H_8N_2O$–$C_6H_3N_3O_6$...	40.79	3.11	19 83	64.88

Hydrochloride of the base :– The hydrochloride was prepared from the purified picrate and recrystallized from alcohol.

It forms colorless, thin prisms, readily soluble in water, sparingly soluble in absolute alcohol but insoluble in ether, benzene etc. and melts at 237°C (Uncorr.). It gives white precipitate either with phosphotungstic acid or with mercuric chloride. When heated, it gives the pyrrol-reaction, while biuret, millon's, and diazo reactions are negative. Dried at 100°C in vacuo and analysed ;

a) Nitrogen :–

No.	Subst. mg	Vol. of N. c c.	Vol -Correction c.c.	Temp. C.	Atmosph-Press. mm.	N %
1	4.33	0.637	0.65—2Vol%	16	767	17.54
2	4.50	0.666	0.68—2Vol%	16	767	17.64

b) Carbon and hydrogen :–

No.	Subst. mg.	CO_2 mg.	H_2O mg.	C %	H %
3	7.63	13.34	3.80	47.68	5.35
4	7.53	13.42	3.68	48.61	5.51

Found / by Pregl's micro-method	C %	H%	N %	Cl%
1).....	47.68	5.53	17.54	—
2).....	48.61	5.51	17.64	—
Calculated for .. $C_6H_8N_2O$–HCl	45·86	5.10	17.61	22.26

Chloro-platinate of the base :– The chloroplatinate was prepared by

adding an alcoholic solution of platinum chloride to the aqueous solution of the hydrochloride.

It crystallizes in deep orange, thick plates, sparingly soluble in water, and melts at 283°C (Uncorr.).

It was dried at 100°C in vacuo and analysed;

a) Nitrogen :-

No.	Subst. mg.	Vol. of N. c.c.	Vol.-Correction c.c.	Temp C.	Atmosph-Press. mm.	N %
1	6.46	0.451	0.46—2Vol%	16	767	8.34
2	6.45	0.451	0.46—2Vol%	17	767	8.36

b) Carbon and hydrogen :-

No.	Subst. mg.	CO_2 mg.	H_2O mg.	Pt mg.	C %	H %	Pt %
3	8.80	7.35	2.04	2.61	22.75	2.58	29.69
4	8.27	6.97	2.06	2.47	22.93	2.77	29.87
5	8.78	7.42	1.97	2.64	23.05	2.52	30.07

Found / by Pregl's micro-method.	C %	H %	N %	Pt %
1)	22.75	2.58	8.34	29.69
2)	22.93	2.77	8.36	29.87
3)	23.05	2.52	—	30.07
Calculated for $(C_6H_8N_2O)_2H_2PtCl_6$	21.95	2.44	8.54	28.20

From these results, it is proper to conclude that the free base has the formula $C_6H_8N_2O$. Further studies on this compound will be reported later on.

e) The filtrate from the fraction (d) was treated with hydrochloric acid and sulphuric acid to remove the excess of silver and barium. A 50% aqueous solution of phosphotungstic acid was then added, after making the contents of sulphuric acid to 5% of the solution. A voluminous precipitate, thus formed, was decomposed with baryta water in usual way. The filtrate was evaporated to a small volume and picric acid was added.

28) Cholin picrate ;- On cooling the solution, cholin picrate separated in large prisms which were recrystallized from hot dilute alcohol. Yield: 42g.

It forms characteristic large yellow prisms, readily soluble in hot water and alcohol, melting at 249°C (Uncorr.). Dried at 100°C in vacuo and analysed.

a) Nitrogen :-

No.	Subst. mg.	Vol. of N. c.c.	Vol.-Correction c.c.	Temp. C.	Atmosph-Press. mm.	N %
1	4.66	0.647	0.66—2Vol%	17	760	16.34
2	4.21	0.578	0.59—2Vol%	17	764	16.24

b) Carbon and hydrogen :-

No.	Subst. mg.	CO_2 mg.	H_2O mg.	C %	H %
3	8.74	12.06	4.13	37.63	5.25

Found / by Pregl's micro-method.	C %	H%	N %
1)	37.63	5.25	16.34
2)	—	—	16.24
Calculated for $C_5H_5NO_2$-$C_6H_3N_3O_7$	37.71	5.14	16.00

The analysis agrees with cholin picrate.

29) Picrate of nicotinic acid :- The mother liquor from cholin picrate was treated with a slight excess of picric acid. On cooling, the picrate of nicotinic acid separated out. It was recrystallised from dilute alcohol. Yield: 12g. Light yellow, thick plates, melting at 219°C (Uncorr.).

a) Nitrogen :-

No.	Subst. mg.	Vol. of N. c c.	Vol.-Correction c.c.	Temp. C.	Atmosph-Press. mm.	N %
1	4.96	0.676	0.69—2Vol%	17	760	16.04

b) Carbon and hydrogen :-

No.	Subst. mg.	CO_2 mg.	H_2O mg.	C %	H %
2	7.86	12.00	1.73	41.64	2.45
3	7.71	11.65	1.54	41.21	2.22

Found / by Pregl's micro-method.	C %	H%	N %
1)	41.64	2.45	16.04
2)	41.21	2.22	—
Calculated for $C_5H_4NCO_2H$-$C_6H_3N_3O_7$	41.19	2.27	15.91

[C] The filtrate from the phosphotungstic acid precipitate [B] was treated with baryta to remove an excess of phosphotungstic acid as well as sulphuric acid. The filtrate freed from baryta, was evaporated in vacuum to a small bulk and kept in a cool place. White spherical crystals of thymin first separated out.

30) Thymin :- The crude crystals were recrystallized from hot water. Yield : 9g.

It forms short, white needles, sparingly soluble in cold water, readily soluble in hot water, and melts at 318–321°C (Uncorr.). It gives diazo-reaction. With ammoniacal silver solution, it gives white precipitate but no precipitate either with phosphotungstic acid or with picric acid. Dried at 100°C in vacuo and analysed ;

a) Nitrogen :-

No.	Subst. mg.	Vol. of N. c.c.	Vol.-Correction c.c.	Temp. C.	Atmosph-press. mm.	N %
1	6.16	1.186	1.21 —2Vol%	17	760	22.66
2	4.80	0.916	0.935— "	17	764	22.58
3	4.75	0.931	0.95 — "	18	750	22.87

b) Carbon and hydrogen :-

No.	Subst. mg.	CO_2 mg.	H_2O mg.	C %	H %
4	7.77	13.21	3.15	46.37	4.51
5	7.83	13.23	3.09	46.08	4.38

Found / by Pregl's micro-method.	C %	H%	N %
1)	46.37	4.51	22.66
2)	46.08	4.38	22.58
3)	—	—	22.87
Calculated for $C_5H_6O_2N_2$	47.62	4.76	22.22

The analysis agrees with thymin (Methyldioxypyrimidin).

31) Leucin :- The filtrate from thymin gave, on further concentration white spherules of leucin which were recrystallized from dilute alcohol. Yield : 4.8g.

Colorless thin plates, readily soluble in hot water, melting at 288°C (Uncorr.) with decomposition. It forms a blue copper salt, and gives a violet coloration by heating with ninhydrin.

a) Nitrogen :-

No.	Subst. mg.	Vol. of N. c.c.	Vol.-Correction c.c.	Temp. C.	Atmosph-press. mm.	N %
1	6.02	0.6125	0.625—2Vol%	17	762	10.35
2	5.98	0.534	0.545— "	18.5	756	10.40

b) Carbon and hydrogen :-

No.	Subst. mg.	CO_2 mg.	H_2O mg.	C %	H %
3	7.64	15.56	6.87	55 54	9.99

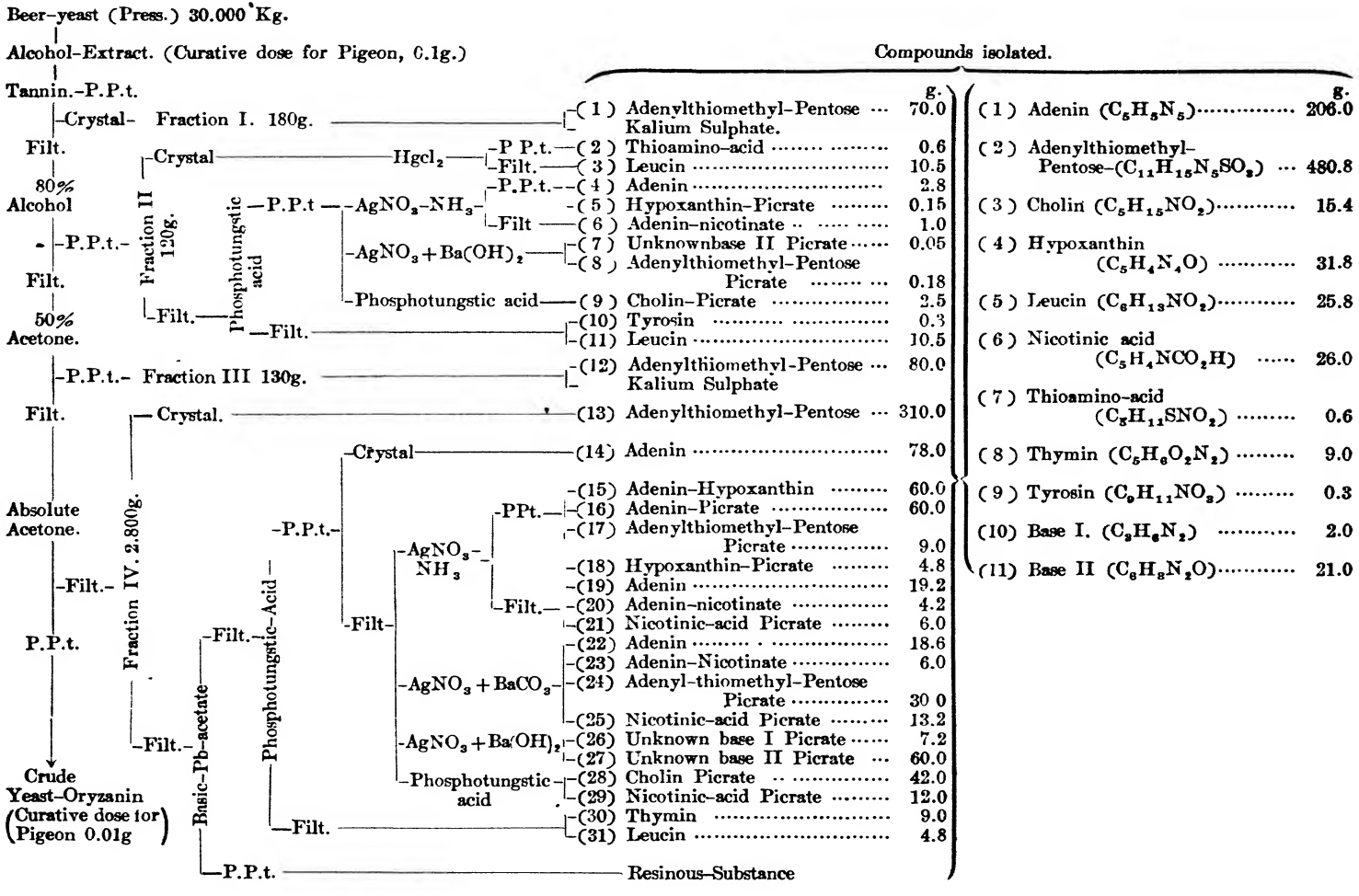
Found / by Pregl's micro-method.	C %	H%	N %
1)	55.54	9.99	10.35
2)	—	—	10.40
Calculated for $C_6H_{13}O_2N$	54.97	9.99	10.69

Summary

The above results are summarized in the following scheme :-

In conclusion, the author desires to express his gratitude to Prof. U. Suzuki, who has continually encouraged and guided whenever needed, so as this work has taken the course unimpeded.

(Tokyo, Apr. 10th. 1927.)


Beer-yeast (Press.) 30.000 Kg.
Alcohol-Extract. (Curative dose for Pigeon, 0.1g.)
Tannin.-P.P.t.
-Crystal- Fraction I. 180g.
Filt.
80% Alcohol
-P.P.t.-
Filt.
50% Acetone.
-Crystal
Hgcl2
-P P.t.
-Filt.
Fraction II 120g.
-P.P.t
-AgNO3-NH3-
-P.P.t.
-Filt
-AgNO3+Ba(OH)2
Phosphotungstic acid
-Phosphotungstic acid
-Filt.
-Filt.
-P.P.t.- Fraction III 130g.
Filt.
Absolute Acetone.
-Filt.-
P.P.t.
Crude Yeast-Oryzanin (Curative dose for Pigeon 0.01g)
-Crystal.
Fraction IV. 2.800g.
-Filt.-
Basic-Pb-acetate
-Filt.
-P.P.t.
Phosphotungstic-Acid
-Filt.
-Crystal
-P.P.t.-
-Filt-
-AgNO3-NH3-
-PPt.
-Filt.
-AgNO3+BaCO3
-AgNO3+Ba(OH)2
-Phosphotungstic acid
-Filt.
Compounds isolated.
g.
(1) Adenylthiomethyl-Pentose Kalium Sulphate. 70.0
(2) Thioamino-acid 0.6
(3) Leucin 10.5
(4) Adenin 2.8
(5) Hypoxanthin-Picrate 0.15
(6) Adenin-nicotinate 1.0
(7) Unknownbase II Picrate 0.05
(8) Adenylthiomethyl-Pentose Picrate 0.18
(9) Cholin-Picrate 2.5
(10) Tyrosin 0.3
(11) Leucin 10.5
(12) Adenylthiomethyl-Pentose Kalium Sulphate 80.0
(13) Adenylthiomethyl-Pentose 310.0
(14) Adenin 78.0
(15) Adenin-Hypoxanthin 60.0
(16) Adenin-Picrate 60.0
(17) Adenylthiomethyl-Pentose Picrate 9.0
(18) Hypoxanthin-Picrate 4.8
(19) Adenin 19.2
(20) Adenin-nicotinate 4.2
(21) Nicotinic-acid Picrate 6.0
(22) Adenin 18.6
(23) Adenin-Nicotinate 6.0
(24) Adenyl-thiomethyl-Pentose Picrate 30 0
(25) Nicotinic-acid Picrate 13.2
(26) Unknown base I Picrate 7.2
(27) Unknown base II Picrate 60.0
(28) Cholin Picrate 42.0
(29) Nicotinic-acid Picrate 12.0
(30) Thymin 9.0
(31) Leucin 4.8
Resinous-Substance
g.
(1) Adenin (C5H5N5) 206.0
(2) Adenylthiomethyl-Pentose-(C11H15N5SO2) 480.8
(3) Cholin (C5H15NO2) 15.4
(4) Hypoxanthin (C5H4N4O) 31.8
(5) Leucin (C6H13NO2) 25.8
(6) Nicotinic acid (C5H4NCO2H) 26.0
(7) Thioamino-acid (C5H11SNO2) 0.6
(8) Thymin (C5H6O2N2) 9.0
(9) Tyrosin (C9H11NO3) 0.3
(10) Base I. (C3H8N2) 2.0
(11) Base II (C6H8N2O) 21.0

PHYSICAL AND CHEMICAL INVESTIGATIONS OF RICE AS RAW MATERIAL OF SAKÉ.

By HISAYE SATOW.

CONTENTS.

INTRODUCTION.

While the greater part of our output of rice is consumed as food-stuff, just a small part such as about six to seven per cent of it is estimated to be used as the raw material of Saké. Many physical and chemical researches of rice have hitherto been made from the stand point of food, but very few have been made as the raw material of Saké. From the former point of view O. Kellner,[1, 2] Y. Kozai,[33] M. Nagaoka,[2, 4] M. Sawamura,[3, 22, 25] S. Kato,[24] I. Inagaki,[9, 11, 16] H. Ando,[33] U. Suzuki,[7, 8, 9, 12, 13, 33, 39] K. Aso, [9, 29, 31] and M. Kondo,[17, 18, 20] and many others have made various useful researches, of which, the discovery of oryzanin made by U. Suzuki deserves special attention. From the latter view point i. e. as raw material of Saké, however, few reports exist such as made by T. Takahashi,[43, 44] T. Tadokoro, [35 36 37 38 45 46] the author[42 43 44] and by others, but these are not enough to define the quantities of rice as the raw material of Saké.

The researches on rice as the food-stuff have been done in general as to the varieties, manures, soils, climates, and the mode of cultivation. The main results of physical and chemical researches in these respects are to be summarised as follows. Among the typical varieties belonging to large kernel may be mentioned Omachi, Miyako, Watashibune and Shiratama: among middle sized ones Shinriki, Aikoku, Ohmi, Ishiziro and Araki and among small varieties Shekitori and Shinshukaneko. The number of varieties amounts to almost ten thousands. Preference of the varieties of rice differs according to districts, viz. prefectures of Kwanto prefer small grains, on the other hand, prefectures of Kwansai prefer large one. From the standpoint of cultivation, varieties of small kernel are fitted to Tohoku prefectures and those of middle sized grain to Tokai, Tosan prefectures, while those of large grain are best for Chugoku, Shikoku and Kyushu prefectures. Regarding

the nature of soil and climate, the best soil is sandy loam formed by the disintegration of granite, moreover, drainage must be good and abundant supply of irrigation water is necessary, while the quantity of rain during summer time must be small. Too much rain brings about the deficit of heat in consequence and the propagation of rice plant is injured. Clay soil is not entirely unfit for rice plantation, as loss of manure is small, and crop is abundant, but the quality of rice is expected to be inferior. Tohoku prefectures prefer varieties of the early crop, while prefectures of Shikoku and Kyushu rather prefer varieties of the later crop taking both the quality as well as quantity of the crop in consideration. When nitrogenous manure is given copiously, the yield of rice may be increased, but on the other hand, the quality of rice will generally be inferior, since the harvest is delayed, and the crop is mixed with a quantity of red rice and inferior one. When nitrogenous manure is lessend and phosphoric and potash manure is increased, the quality of rice may be superior, and the harvest earier, but the crop is decreased. If we aim to obtain both the best quality and the largest yield, we must give suitable quantities of nitrogenous, phosphatic and potash manures. Indirect manure, such as lime, when given in a greater quantity than normal, brittleness of rice grains may follow. Of chemical compositions, the quantities of starch and nitrogen must be great and those of water, cellulose and ash must be small. Since starch is the principal constituent of rice constituting the endosperm, there is no objection as to the assertion that the rice is better when rich in starch. Regarding nitrogen, the experiments hitherto made on the same varieties in the same climate, shows that the quality of rice is better when the quantity of nitrogen is the greater. Rice produced in India, Java and in several districts, where lime is abused contain less nitrogen and the quality is regarded to be inferior. Potassium, calcium, phosphorous, sodium, iron and magnesium are necessary ingredients as nutritious matter, but these are not taken into consideration in the judgment of the quality of rice. In regard to the fat, it is better that the rice contains it much, since the fat is indispensable for the human nutrition. Water contents ought to be small. Much water makes the percentage of other important constituents lower, diminishes the preservative power, produces, moreover, crushed grains during polishing. Cellulose is chiefly contained in the bran. Abundant content of it, is objectionable as it is unnecessary for the nutrition. After all, for the food purpose the quantities of starch, nitrogen and fat in rice are desirable to be large, while water, cellulose and ash contents ought to be as small as possible. Regarding the physical properties, the following conditions are necessary–purity, luster, light colour, high degree of hardness, thickness in bredth, thin bran layer, shallow longitudinal furrow,

high specific gravity, heavy weight and less Harasiromai (the lateral part of rice kernel is white and opaque).

The selection of rice for the material of Saké brewing has been a matter of mere experience until now. They thought that rice must be ordinary rice produced on paddy field, not over ripened and harvested rather in an earier period. It must possess high degree of purity, luster, light colour, heavy weight, enough thickness, thin bran layer, shallow longitudinal furrow, moderate hardness, and humidity. Rice used in Nada district, belongs to the medium variety produced in prefectures of Settsu and Harima. If grains are too hard in consequence of extreme drying or less water contents or overripening, then abundant Dowaremai (rice grain cracked) will be produced. Such hard grains produce greater loss during polishing as broken grains. When such hard rice is used as Koji, the growth of mycelium of the Koji fungus is damaged and consequently the saccharification is insufficient during mashing, and the equilibrium among saccharification, fermentation, and acid formation is disturbed. In such a case, fermentation of mash begins comparatively earlier but it is weak and tedious so that the consumption of sugar is dull accompanied by a copious formation of acid and bad flavour, resulting in an inferior product. On the contrary, if grains are too soft in consequence of insufficient drying or unripeness, greater loss is produced also during polishing as broken grains. In such a case saccharification preceeds too quickly and the fermentation is retarded, resulting deep coloured, strongly acidic, sweet mash destitute of alcohol. In short, the rice to be used for Saké brewing must be of large, rather soft grains, and contain abundant starch. In other respects, no reliable data have yet been given.

Regarding the nature of soil, sandy loam, viz. granite soil is regarded to be best fitted for the rice plantation and those granite districts such as prefectures of Settsu, Harima and Bizen are thought to produce the best kind of rice.

As previously mentioned, the judgment of rice to be used for Saké brewing has been done chiefly concerning its physical properties. Probably the chemical changes of rice during Saké brewing are more or less complicated according to the treatment given by the brewer. So the quality of Saké is dependent not only on the quality of rice, but also on the skill of the brewer and other accidental circumstances. Suitable technical treatment is, of course, very important. Moreover, qualities of water and vat of the aging constitute important factors in the quality of the product, further more climate has an important influence on the fermentation. Apart from these causes, the quality of rice has a predominant relation to the quality of Saké produced. The choice of the rice for the brewing is not, however, a matter

of concordance in different districts, as the brewers select their raw materials only from their experiences. It is beyond doubt that we wanted a reliable standard for the selection of rice as the raw material of Saké brewing. The author intended to investigate the numerous varieties of rice produced in several districts. The object of this investigation is to determine the physical and chemical properties of husked rice, which is regarded to be suitable for Saké brewing. The experiments have been conducted on 242 varieties including husked and polished rice, covering the production of five years.

Experiments.

a) Percentage of the full grown grains :——100g. of each sample were spread on a smooth black paper, all impurities except the full grown grains were collected and weighed. The weight was deducted from 100. The remainder shows the percentage of the full grown grains.

b) External appearance and luster :——definite quantities of each sample were placed on a white paper side by side and their external appearance, luster and shade of colour were compared.

c) Size of grains. (mm.) :——100g. of each sample were first sifted through a sieve of perforations of 2.2mm. diameter and then of 2.0mm., 1.8mm. and finally of 1.6mm. Among them 50 grains were taken out in proportion, and their length and width were measured.

d) Percentage of Shinziromai (grains with opaque centre) :——50g. of each sample were reflected through a diaphanoscope.

e) Depth of longitudinal furrow (μ) :——10 full grown grains were cut cross ways just in two parts with a razor, and the two furrows on both sides of the grains were measured under a microscope of a low power with an ocular micrometer.

f) Specific gravity :——20g. of each sample were plunged into a burette containing 90 % alcohol, and the weight is divided by the c.c. of volume occupied.

g) Saccharifying quality :——One g. of powdered sample was added with 100c.c. of water and boiled for 30 minutes with a reverted cooler; when cooled, 52.5c.c. water and 7.5c.c. Koji extract were added. (25g. Koji, added with 50c.c. water were kept for 6 hours with stirring from time to time and then filtered.)

This mixture was kept in a thermostat of 28.5°C. for 2 hours, then boiled, cooled, filled up to 200c.c. of which 10c.c. were used for the determination of sugar (A). As controle, 7.5c.c. of the above mentioned Koji extract, added with 152.5c.c. water were kept in a thermostat of 28.5°C. for 2 hours, treated as above, and the sugar contents were determined (B).

Powdered rice was also analysed on sugar (C).

Sugar produced = A − (B + C)

h) Hardness (kilo):——50 or 100 grains were tested with Ando's "Festigkeit Prüfer."

i) Volume of 100g. (c.c.):—— Brauer's "Getreide Prüfer" was used.

j) Weight of 1,000 grains (g.):——1,000 full grown grains were weighed.

k) Volume of 1,000 grains (c.c.) :——1,000 full grown grains were plunged into 90 % alcohol and the occupied volume was determined.

l) Phytin :——measured according to J. B. Rather's method, (Phytin phosphorous as P_2O_5 in dry matter).

m) Thickness of bran layer (μ) (Pericarp, testa, perisperm and aleuron layer):——Each grain was cut vertically with a razor at 10 places, steeped in n/100 iod-iodpotassium solution, measured with an ocular micrometer. 20 grains of each sample were tested.

n) Absorption of water (%):——To 50g. of rice were added 60c.c. of water and after the time mentioned, the sample was well squeezed from water between dry papers and weighed.

o) Depth of embryo cavity:——A grain was cut cross ways, with a razor into two equal parts, then longitudinally along the embryo cavity, steeped in n/100 iod-iodpotassium solution, and the depth of embryo cavity was measured with an ocular micrometer, using a microscope of a low power. Thus the depth of the cavity is divided by the length of the cavity. 10 grains of each sample were used.

Samples used for experiments were always kept at 26 to 27°C.

p) Chemical analysis :——All constituents were measured by the usual methods.

Analyses of embryo.

7.7g. of embryo were obtained from about 405g. of husked rice, the compositions of the embryo were as follows :—

Water	9.10
Crude protein	20.81
Protein (after Stutzer's method)	20.50
Crude fat	27.52
Ash	8.38
Crude fibre	3.60
Nitrogen free extract	30.55

1916 Production.

a) Husked rice, suitable for the Saké brewing. 18 (A-R) varieties.

A) *Production of Okayama prefecture.*

a) Percentage of full grown grains. ——91.0 %

b) External appearance and luster——grains were fat and large, having a straw yellow waxy luster, with practically no impurities.

c) Size of grains (m.m.)

thickness above	2.2	70.36 g.	35 grains.
〃 〃	2.0	22.60 〃	11 〃
〃 〃	1.8	5.90 〃	3 〃
〃 under	1.8	1.10 〃	1 〃
	average.	max.	min.
length	5.27	5.60	4.90
width	2.98	3.20	2.80

d) Percentage of Shingiromai.——55.64

e) Depth of longitudinal furrow. (μ)—

average.	max.	min.
52.70	87.50	35.0

f) Specific gravity.——1.404

g) Saccharifying quality.—31.98 %

h) Hardness. (kilo)

under 3.75 kilo	2 grains.
3.75—5 63 〃	61 〃
5.63—7.50 〃	30 〃
7.50—9.38 〃	7 〃
above 9.38 〃	—

average.	max.	min.
5.46	8.63	3.19

i) Volume of 100g.——121.5c.c.

j) Weight of 1,000 grains.——26.22g.

m) Thickness of bran layer. (μ)

average	max.	min.
43.38	59.40	33.75

n) Absorption of water.

time steeped.	water absorded.	% absorbed.
1 h.	2.20	4.40
3	4.90	9.80
24	11.47	22.94

c) Depth of embryo cavity :—

average.	max	min.
0.27	0.30	0.21

p) Chemical composition :—

		unhydrous.
Water	13.22	—
Direct R. sugar	2.37	2.61
Dextrin	2.01	2.32
Starch	72.17	83.17

Crude fat	1.76	2.03
〃 fiber	1.23	1.42
〃 protein	6.70	7.72
Ash	1 16	1.34
Puosphoric acid	0.37	0.43

B) *Production of Okayama prefecture.*

a) Percentage of full grown grains.——94.1 %

b) Luster and external appearance——nearly same as A).

c) Size of grains. (m.m.)

thickness above.	2.2	82.10 g.	41 grains.
〃 〃	2.0	14.22 〃	7 〃
〃 〃	1.8	3.20 〃	2 〃
〃 under	1.8	0.40 〃	—

	average	max.	min.
length	5.30	5.60	4.70
width	2.97	3.20	2.80

d) Percentage of Shinziromai.——79.10 %

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
51.63	78.75	29.75

f) Specific gravity. 1.404

g) Saccharifying quality. 35.41 %

h) Hardness. (kilo)

under 3.75	23 grains
3.75—5.63	64 〃
5.63—7.50	10 〃
7.50—9.38	3 〃
above 9 38	—

average.	max.	m'n.
4.39	8.86	2 55

i) Volume of 100g.——122.0c.c.

j) Weight of 1,000 grains.——26.97g.

m) Thickness of bran layer. (μ)

average.	max.	min.
42.65	56.25	33.75

n) absorption of water.

time steeped.	water adsorbed.	% absorbed
1 h.	2.05	4.1
3	4.50	9.0
24	10.70	21.40

o) Depth of embryo cavity.

average.	max.	min.
0.25	0.29	0.19

p) Chemical composition :——

		unhydrous.
Water	13.99	—
Direct R. sugar	2.94	3.41
Dextrin	1.63	1.89
Starch	70.29	81.72
Crude fat	1.85	2.15
〃 fibre	0.99	1.15
〃 protein	6.88	8.00
Ash	1.16	1.35
Phosphoric acid	0.35	0.41

C) *Production of Okayama prefecture.*

a) Percentage of full grown grains.——91.95 %

b) External appearance and luster——nearly same as A).

c) Size of grains. (m.m.)

thickness above.	2.2	75 10 g.	38 grains.
〃 〃	2.0	18.80 〃	9 〃
〃 〃	1 8	5.20 〃	3 〃
〃 under.	1 8	0.80 〃	—

	average.	max.	min.
length	5.37	5 70	4.90
width	3.00	3 30	2.70

d) Percentage of Shinziromai :——64.3 %

e) Depth of longitudinal furrow. (μ)

average	max	min.
46.74	87 50	17.50

f) Specific gravity.——1.389.

g) Saccharifying quality.——33.80 %

h) Hardness. (kilo)

under 3.75 kilo	— grains
3.75—5.63 〃	60 〃
5.63—7.50 〃	35 〃
7 50—9.38 〃	5 〃
above 9 38 〃	—

average.	max.	min.
5.55	7.69	3 94

i) Volume of 100g.——125.0c.c.

j) Weight of 1,000 grains.——26.95g.

m) Thickness of bran layer. (μ)

average	max.	min.
41.36	54 06	29.25

n) Absorption of water.

time steeped.	water absorbed.	% absorbed.
1 h.	2.05 gr.	4.1
3	4.75 〃	9.50
24	10.39 〃	20.60

o) Depth of embryo cavity.

average.	max.	min.
0.26	0 34	0.23

p) Chemical composition :—

		unhydrous.
Water	13.56	—
Direct R. sugar	1 55	1.80
Dextrin	1.38	1.59
Starch	72.65	84.05
Crude fat	2.13	2.47
〃 fibre	1.01	1.17
〃 protein	7.32	8.47
Ash	1.22	1.41
Phosphoric acid	0.37	0.43

D) *Production of Osaka prefecture.*

a) Percentage of full grown grains.——92.3 %

b) External appearance and luster.——nearly same as A).

c) Size of grains. (m.m.)

thickness above	2 2	53.70 g.	27 grains
〃 〃	2.0	28.00 〃	14 〃
〃 〃	1.8	17.10 〃	9 〃
〃 under	1.8	1.10 〃	—

	average.	max.	min.
length	5.20	5.60	4.60
width	2.94	3.20	2.40

d) Percentage of Shinziromai.——49.92 %

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
61.9	105.0	35.0

f) Specific gravity.——1.399

g) Saccharifying quality.——29.93 %

h) Hardness. (kilo)

under 3.75 kilo	— grains.
3.75—5.63 〃	33 〃
5 63—7.50 〃	49 〃
7 50—9.38 〃	18 〃
above 9.38	—

average	max.	min.
6.28	9.26	3.86

i) Volume of 100g.——124.0c.c.

j) Weight of 1,000 grains. ——24.70g.

m) Thickness of bran layer. (μ)

average.	max.	min.
41.48	49.50	33.75

n) Absorption of water.

time steeped.	water absorbed.	% absorbed.
1 h.	2.90	5.8
3	6.35	12.7
24	12.02	24.04

o) Depth of embryo cavity.

average.	max.	min.
0.26	0.34	0.15

p) Chemical composition ·—

		unhydrous.
Water	12.64	—
Direct R. sugar	2.42	2.77
Dextrin	1.92	2.20
Starch	71.17	81.47
Crude fat	2.19	2.51
〃 fibre	1.02	1.17
〃 protein	6.88	7.87
Ash	1.37	1.46
Phosphoric acid	0.60	0.69

E) *Production of Hyogo prefecture.*

a) Percentage of full grown grains.——88.05%.

b) External appearance and luster.——nearly same as A), but rather of middle size.

c) Size of grains. (m.m.)

thickness above	2.2	23.50 g.	12 grains.
〃 〃	2 0	44.40 〃	22 〃
〃 〃	1.8	29.00 〃	15 〃
〃 under	1.8	2 90 〃	1 〃

	average.	max.	min.
length	5.31	5.70	4 50
width	2.97	3.20	2.50

d) Percentage of Shinziiomai.——79.7 %

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
55.88	86.50	34.60

f) Specific gravity.——1.399

g) Saccharifying quality.——32.83 %

h) Hardness. (kilo)

under 3.75	1 grains.
3.75—5.63	26 "
5.63—7.50	42 "
7.50—9.38	29 "
above 9.38	2 "

average.	max.	min.
6.681	10.02	3.4875

i) Volume of 100g.——124.0c.c.

j) Weight of 1,000 grains.——24.20g.

m) Thickness of bran layer. (μ)

average.	max.	min.
43.97	59.40	36.00

n) Absorption of water.

time steeped.	water absorbed	% absorbed.
1 h.	2.68	5.36
3	5 67	11.34
24	12.27	24.54

o) Depth of embryo cavity.

average	max.	min.
0 30	0.40	0.22

p) Chemical composition :—

		unhydrous.
Water	12.37	—
Direct R. sugar	2.52	2.88
Dextrin	2.04	2.33
Starch	70.39	80.93
Crude fat	2.25	2.57
" fibre	1.03	1.18
" prote'n	8.04	9.18
Ash	1.42	1.62
Phosphoric acid	0.43	0.49

F) *Production of Hyogo prefecture.*

a) Percentage of full grown grains.——96.7 %

b) External appearance and luster.——nearly same as A).

c) Size of grains. (m.m.)

thickness above	2.2	58.40 g.	29 grains.
" "	2.0	33.00 "	17 "
" "	1.8	7.90 "	4 "
" under	1.8	0 60 "	—

	average.	max.	min.
length	5.16	5.60	4.60
width	2.98	3.20	2.60

d) Percentage of Shinziromai.——83.0 %

e) Depth of longitudinal furrow. (μ)

under 3.75	4 grains.
3.75—5.63	51 〃
5.63—7.50	34 〃
7.50—9.38	11 〃
above 9.38	—

average.	max.	min.
5.64	8.25	3.49

i) Volume of 100g.——119.0c.c.

j) Weight of 1,000 grains.——25.10g.

m) Thickness of bran layer. (μ)

average.	max.	min.
45.72	51.75	39.15

n) Absorption of water.

time steeped.	water absorbed	% absorbed
1 h.	1.80	3.60
3	3.85	7.70
24	10.30	20.60

o) Depth of embryo cavity.

average.	max.	min.
0.25	0.33	0.21

p) Chemical composition.—

		unhydrous.
Water	12.88	—
Direct. R. sugar	3.16	3.63
Dextrin	1.26	1.42
Starch	70.59	81.03
Crude fat	2.37	2.72
〃 fibre	0.99	1.14
〃 protein	6.97	8.00
Ash	1.24	1.42
Phosphoric acid	0.37	0.41

G) *Production of Kumamoto prefecture.*

a) Percentage of full grown grains.——83.8 %

b) External appearance and luster.——nearly same as A) but impurities were tolerably abundant.

c) Size of grains. (m.m.)

thickness above	2.2	49.80 g.	25 grains.
〃 〃	2.0	35.20 〃	18 〃
〃 〃	1.8	12.90 〃	6 〃
〃 under	1.8	1.90 〃	1 〃

	average.	max.	min.
length	5.08	5.50	4.50
width	2.98	3.20	2.60

d) Percentage of Shinziromai.——11.7 %

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
60.98	86.50	43.25

f) Specific gravity.——1.384

g) Saccharifying quality.——30.29 %

h) Hardness. (kilo)

under 3.75	2 grains.
3.75—5.63	32 〃
5.63—7 50	44 〃
7.50—9.38	21 〃
above 9.38	1 〃

average.	max.	min.
6.38	9.83	3.38

i) Volume of 100g.——126.0c.c.

j) Weight of 1,000 grains.——23.90g.

m) Thickness of bran layer. (μ)

average.	max.	min.
45.71	67.50	36 45

n) Absorption of water.

time steeped.	water absorbed	% absorbed.
1 h.	2.45	4.9
3	4.97	9.94
24	10.57	21.14

o) Depth of embryo cavity.

average.	max.	min.
0.26	0.31	0.21

p) Chemical composition.—

		unhydrous.
Water	13.15	—
D. R. sugar	2.06	2.38
Dextrin	2.23	2.57
Starch	71.80	82.67
Crude fat	2 08	2.40
〃 fibre	1.13	1.30
〃 protein	7.15	8.25
Ash	1.35	1.56
Phosphoric acid	0.40	0.45

H) *Production of Yehime profecture.*

a) Percentage of full grown grains.——87.2%.

b) External appearance and luster.——nearly same as A).

c) Size of grains. (m.m.)

thickness above	2.2	49.10 g.	25	grains.
〃 〃	2.0	35.90 〃	18	〃
〃 〃	1.8	12.40 〃	6	〃
〃 under	1.8	2.20 〃	1	〃

	average.	max.	min.
length	5.11	5.70	4.60
width	2.95	3.30	2.50

d) Percentage of Shinziromai.——27.7 %

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
58.39	86.50	25.95

f) Specific gravity.——1.394

g) Saccharifying quality.——24.93 %

h) Hardness. (kilo)

under 3.75 kilo	5 grains.
3.75—5.63	63 "
5.63—7.50	30 "
7.50—9.38	2 "
above 9.38	—

average.	max.	min.
5.23	8.74	3.43

i) Volume of 100g.——129.0c.c.

j) Weight of 1,000 grains.——24.45g.

m) Thickness of bran layer. (μ)

average.	max.	min.
46 02	56.25	37.35

n) Absorption of water.

time steeped.	water absorbed.	% absorbed.
1 h.	3.20	6.4
3	6 80	13.6
24	10.97	21.94

o) Depth of embryo cavity.

average.	max.	min.
0.26	0.31	0.19

p) Chemical composition.—

		unhydrous.
Water	13 86	—
D. R. sugar	2.42	2.80
Dextrin	1.33	1.55
Starch	71.52	83.03
Crude fat	2.07	2.40
" fibre	1.20	1.39
" protein	6.43	7.47
Ash	1.33	1.54
Phosphoric acid	0.54	0.63

I) *Production of Miye prefecture.*

a) Percentage of full grown grains.——92.6%

b) External appearance and luster.——nearly same as A).

c) Size of grains. (m.m.)

thickness above	2.2	66.30 g.	33 grains.
〃 〃	2.0	25.5 〃	13 〃
〃 〃	1.8	7.8 〃	4 〃
〃 under	1.8	0.4 〃	— 〃

	average.	max.	min.
length	5.28	5.70	4.90
width	2 98	3.20	2.70

d) Percentage of Shinziromai.——79.12%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
68.16	117.25	35.0

f) Specific gravity.——1.399%.

g) Saccharifying quality.——37.99%

h) Hardness. (kilo)

under 3.75 kilo	2 grains.
3.75—5.63	70 〃
5.63—7.50	24 〃
7 50—9.38	4 〃
above 9.38	—

average.	max.	min.
5.17	7.99	3.47

i) Volume of 100g.——123.5c.c.

j) Weight of 1,000 grains.——26.21g.

m) Thickness of bran layer. (μ)

average.	max.	min.
46.31	67.50	33 75

n) Absorption of water.

time steeped.	water absorbed.	% absorbed.
1 h.	2 17	4 34
3	4 90	9 80
24	10.77	21.54

o) Depth of embryo cavity.—

average.	max.	min.
0.28	0.35	0.23

p) Chemical composition.—

		unhydrous.
Water	13.59	—
D. R. sugar.	2.26	2.62
Dextrin	2.04	2.36
Starch	71.53	82.79
Crude fat	1.96	2.27
〃 fibre	1.02	1.18
〃 protein	6.79	7.86

Ash	1.12	1.29
Phosphoric acid	0.36	0.41

J) *Production of Niigata prefecture.*

a) Percentage of full grown grains.——92.4 %

b) External appearance and luster.——somewhat greenish yellow, grains were not fat of midddle size, impurities were rare.

c) Size of grains. (m.m.)

thickness above	2.2	44.10 g.	22 grains.
〃 〃	2.0	36.5 〃	18 〃
〃 〃	1.8	17.6 〃	9 〃
〃 under	1.8	1·5 〃	1 〃

	average.	max.	min.
length	5.11	5.40	4.60
width	2.87	3.20	2.50

d) Percentage of Shinziromai.——8.84 %

e) Depth of longitudinal furrow.(μ)——

average.	max.	min.
58.13	87.50	29.75

f) Specific gravity.——1.389.

g) Saccharifying quality.——38.11 %

h) Hardness. (kilo)—

under 3.75	—
3.75—5.63	39 grains.
5.63—7.50	58 〃
7 50—9.38	3 〃
above 9.38	—

average.	max.	min.
5.88	7.73	3.94

i) Volume of 100g.——128.5c.c.

j) Weight of 1,000 grains.——23.44g.

m) Thickness of bran layer. (μ)

average.	max.	min.
54.61	96 75	36.00

n) Absorption of water.

time steeped.	water absorbed.	% absorbed.
1 h.	3.68	7.36
3	7.25	14.50
24	11.00	27 00

o) Depth of embryo cavity.

average.	max.	min.
0.25	0.33	0.20

p) Chemical composition.—

		unhydrous
Water	13.97	—
D. R. sugar	2.24	2.60
Dextrin	1.83	2.13
Starch	69.80	81.13
Crude fat	2.08	2.41
" fibre	0.99	1.15
" protein	7.51	8.73
Ash	1.29	1.49
Phosphoric acid	0.40	0.47

K) *Production of Kagawa prefecture.*

a) Percentage of full grown grains.——85.26%

b) External appearance and luster.——nearly same as J).

c) Size of grains. (m.m.)

thickness above	2.2	62.20 g.	31 grains.
" "	2.0	27.90 "	14 "
" "	1.8	8.90 "	4 "
" under	1 8	1.00 "	1 "
	average.	max.	min.
length	5.20	5.60	4.40
width	2.95	3.10	2.60

d) Percentage of Shinziromai.——63.04%

e) Depth of longitudinal furrow. (μ)

average	max.	min.
50.69	95.15	25.95

f) Specific gravity.——1.4056

g) Saccharifying quality.——36.16%

h) Hardness. (kilo)

under 3.75		3 grains.
3.75—5 63		40 "
5.63—7.50		38 "
7.50—9.38		17 "
above 9.38		2 "
average.	max.	min.
6 03	9.68	3.53

i) Volume of 100g.——124.5c.c.

j) Weight of 1,000 grains.——25.41g.

m) Thickness of bran layer. (μ)

average.	max.	min.
45.63	56.25	37.58

n) Absorption of water.

time steeped	water absorbed.	% absorbed.
1 h.	2.40	4.8
3	5.60	11.2
24	11.85	23.70

o) Depth of embryo cavity.

average.	max.	min.
0.24	0.26	0.19

h) Chemical composition.—

		unhydrous.
Water	13.04	—
D. R. sugar	1.19	1.37
Dextrin	1.12	1.42
Starch	72.07	82.86
Crude fat	2.11	2.43
" fibre	1.17	1.35
" protein	7.44	8.49
Ash	1.22	1.40
Phosphoric acid	0.34	0.39

L) *Production of Miyagi prefecture.*

a) Percentage of full grown grains.——69.3%

b) External appearance and luster.——Somewhat deep straw brown yellow, no luster, grains were large and fat, impurities were abundant.

c) Size of grain. (m.m.)

thickness above	2.2	76 50 g.	38 grains.
" "	2.0	16.10 "	8 "
" under	2.0	7.40 "	4 "

	average.	max.	min.
length	5.00	5.4	4.5
width	3.10	3 3	2.8

d) Percentage of Shinziromai.——3.2%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
61.95	122.5	26.25

f) Specific gravity.——1.389.

g) Saccharifying quality. — 32.68%

h) Hardness. (kilo)

under. 3.75 kilo.	—
3.75—5.63	19 grains.
5.63—7.50	29 "
7.50—9.38	2 "
above 9.38	—

average.	max.	min.
5.80	7.97	3.94

i) Volume of 100g. —129.0c.c.

j) Weight of 1,000 grains.——26.10g.

m) Thickness of bran layer. (μ)

average.	max.	min.
52.18	85.50	33.75

n) Absorption of water.

time steeped.	water absorbed	% absorbed.
1 h.	3.10	6.20
3	6.45	12.90
24	10.32	20.64

o) Depth of embryo cavity.

average.	max.	min.
0 26	0.31	0.21

p) Chemical composition.

		unhydrous.
Water	16.09	—
D. R. sugar	2.67	3.18
Dextrin	2.18	2.60
Starch	68 42	81.54
Crude fat	0.61	0.73
〃 fibre	0.98	1.17
〃 protein	8.58	10.22
Ash	1.50	1.79
Phosphoric acid	0.43	0.51

M) Production of Fukushima prefecture.

a) Percentage of full grown grains.——93.06%

b) External appearance and luster. — Straw yellow waxy luster, grains were fat and somewhat small, impurities were rare.

c) Size of grains. (m.m.)

thickness above	2.2	8.3 g.	4 grains.
〃 〃	2.0	45.0 〃	23 〃
〃 〃	1.8	44.7 〃	22 〃
〃 under	1.8	1.9 〃	1 〃
	average	max.	min.
length	4.84	5.30	4.30
width	2.71	3.00	2.40

d) Percentage of Shinziromai. ——3.6%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
42.64	69.20	17.30

f) Specific gravity. —1.394

g) Saccharifying quality.——27.21%

h) Hardness. (kilo)

under 3 75 kilo.	— grains.
3.75—5.63	16 〃
5.63—7.50	33 〃
7.50—9.38	1 〃
above 9.38	—

average.	max.	min.
5.82	7.88	4.46

i) Volume of 100g.——128.5c.c.

j) Weight of 1,000 grains.——20.2c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
42.49	63.0	31.5

n) Absorption of water.

time steeped.	water absorbed.	% absorbed.
1 h.	2.90	5.8
3	5.95	11.9
24	10.20	20.4

o) Depth of embryo cavity.

average.	max.	min.
0.23	0.28	0.19

p) Chemical composition.

		unhydrous
Water	14.09	—
D R sugar	5 14	5.98
Dextrin	1.96	2.28
Starch	68 41	79 64
Crude fat	1 67	1.94
〃 fibre	0 87	1 01
〃 protein	7.77	9 04
Ash	1.31	1.52
Phosphoric acid	0.37	0.44

N) *Production of Fukushima prefecture.*

a) Percentage of full grown grains.——75.4%

b) External appearance and luster.——Straw yellow greyish colour, no luster, grains were small and fat, impurities tolerably abundant.

c) Size of grains. (m.m.)

thickness above	2 2	25.4 g.	13 grains.
〃 〃	2 0	34.5 〃	17 〃
〃 〃	1.8	28.5 〃	14 〃
〃 under	1.6	11.4 〃	6 〃

	average.	max	min.
length	4 86	5 20	4.30
width	2.86	3 00	2.50

d) Percentage of Shinziromai. 4.4%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
59.43	95.15	34 60

f) Specific gravity.——1.389.

g) Saccharifying quality.——38.21

h) Hardness. (kilo)

under 3.75	—
3.75—5.63	28 grains.
5.63—7.50	22 〃
7.50—9.38	—
above 9.38	—

average.	max	min.
5.46	7.20	3.94

i) Volume of 100g.——133.5c.c.

j) Weight of 1,000 grains.— — 21.55g.

m) Thickness of bran layer. (μ)

average.	max.	min.
43.75	60.75	36.0

n) Absorption of water.

time steeped.	water absorbed.	% absorbed.
1 h.	4.55	9.10
3	8.15	16.30
24	11.15	22.30

o) Depth of embryo cavity.

average.	max.	min.
0.26	0.30	0.23

p) Chemical composition.—

		unhydrous.
Water	11.97	—
D. R. sugar	2.14	2.51
Dextrin	2.02	2.38
Starch	69.89	82.20
Crude fat	1.89	2.23
〃 fibre	0.84	0.99
〃 protein	7.06	8.30
Ash	1.25	1.47
Phosphoric acid	0.37	0.43

O) *Production of Fukushima prefecture.*

a) Percentage of full grown grains.— -89.6%

b) External appearance and luster.——Straw brown yellow waxy luster, grains were fat and middle size, impurities were rare.

c) Size of grains. (m.m.)

thickness above	2.2	52.60 g.	27 grains.
〃 〃	2.0	34.10 〃	17 〃
〃 〃	1.8	12.00 〃	6 〃
〃 under	1.8	1.10 〃	—

	average.	max.	min.
length.	4.90	5.40	4.30
width	2.92	3.20	2.70

d) Percentage of Shinziromai.——14.0%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
54.24	74.39	34.60

f) Specific gravity.——1.389

g) Saccharifying quality.——20.15%

h) Hardness. (kilo)

under 3.75 kilo	2 grains.
3.75—5 63	25 〃
5.63—7.50	22 〃
7.50—9.38	1 〃
above 9.38	—

average.	max.	min.
5.42	8.03	3.38

i) Volume of 100g.——129.5c.c.

j) Weight of 1,000 grains.——23.5g.

m) Thickness of bran layer. (μ)

average.	max	min.
46.05	63.00	33.75

n) Absorption of water.—

time steeped.	water absorbed.	% absorbed.
1 h	3.22	6.44
3	6.50	13.00
24	10.70	21.40

o) Depth of embryo cavity.

average.	max.	min.
0.29	0.37	0.22

p) Chemical composition.—

		unhydrous
Water	11 36	—
D. R sugar	3.40	3.97
Dextrin	2.25	2.62
Starch	71.01	82.92
Crude fat	1.77	2 07
〃 fibre	1.20	1.40
〃 protein	6 34	7.41
Ash	1.29	1.51
Phosphoric acid	0 46	0.54

P) *Production of Fukushima prefecture.*

a) Percentage of full grown grains.— —87.2%

b) External appearance and luster. ——Somewhat dark straw yellow colour, no luster, grains ware fat and of middle size, impurities were tolerably abundant.

c) Size of grains. (m.m.)

thickness	above	2.2	76.60 g.	38 grains.
〃	〃	2 0	18.50 〃	9 〃
〃	under	2.0	4.80 〃	3 〃

	average.	max.	min.
length	4.87	5.20	4.40
width	3.02	3.10	2.70

d) Percentage of Shinziromai.——4.2%

e) Depth of longitudinal furrow. (μ)

average.	max.	mim.
47.49	86.5	25.95

f) Specific gravity.——1.389

g) Saccharifying quality.——23.37%

h) Hardness. (kilo)

under 3.75 kilo	2 grains.
3.75—5.63	30 "
5.63—7.50	18 "
7.50—9 38	—
above 9.38	—

average.	max.	min.
5.32	7.05	3.45

i) Volume of 100gr.——130.0c.c.

j) Weight of 1,000 grains.——24.7g.

m) Thickness of bran layer. (μ)

average.	max.	min.
48.56	65.25	40 50

n) Absorption of water.

time steeped	water absorbed.	% absorbed
1 h.	2.65	5.30
3	5.55	11.10
24	10.15	20.30

o) Depth of embryo cavity.

average.	max.	min.
0.29	0.34	0.24

p) Chemical composition.—

		unhydrous.
Water	15.57	—
D. R. sugar	2.18	2.59
Dextrin	2 19	2 59
Starch	68.68	81.35
Crude fat	0.68	0 81
" fibre	1.13	1.33
" protein	8.13	9.63
Ash	1:36	1.61
Phosphoric acid	0.43	0.51

Q) *Production of Yamagata prefecture.*

a) Percentage of full grown grains.— 89.64%

b) External appearance and luster.——Grey yellow straw colour, no

luster, grains were small and fat, impurities were tolerably abundant.

c) Size of grains. (m.m.)

thickness	above	2.2	16.70 gr.	8 grains.
〃	〃	2.0	40.80 〃	25 〃
〃	〃	1.8	31.20 〃	16 〃
〃	under	1.8	2.20 〃	1 〃
		average.	max.	min.
	length	4.90	5.50	4.40
	width	2.77	3.10	2.40

d) Percentage of Shinziromai.——0.4%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
40.48	51.90	25.95

f) Specific gravity.——1.394

g) Saccharifying quality.- -39.49%

h) Hardness. (kilo)

under 3.75 kilo	5 grains.
3 75—5.63	27 〃
5 63—7.50	18 〃
7.50—9.38	—
above 9.38	—

average.	max	min.
5 2695	7.375	3.30

i) Volume of 100g. ——128.5c.c.

j) Weight of 1,000 grains.——21.60g.

m) Thickness of bran layer. (μ)

average.	max.	min.
44.64	56.25	33.75

n) Absorption of water.

time steeped.	water absorbed.	% absorbed.
1 h.	3.95	7.90
3	7.80	15.60
24	10.95	21.90

o) Depth of embryo cavity.

average.	max.	min.
0.28	0.33	0.25

p) Chemical composition.—

		unhydrous.
Water	16.23	—
D. R. sugar	2.86	3.41
Dextrin	2.12	2.77
Starch	67.98	81.14
Crude fat	0.72	0.86
〃 fibre	0.98	1.17

" protein	7.41	8.85
Ash	1.37	1.64
Phoshoric acid	0.43	0.52

R) *Production of Yamagata prefecture.*

a) Percentage of full grown grains.——85.8%

b) External appearance and luster.——Straw yellow waxy luster, grains were fat and small, impurities were tolerably abundant.

c) Size of grains. (m.m.)

thickness	above	2.2	45.0 gr.	23 grains.
"	"	2.0	38.2 "	19 "
"	"	1.8	14.4 "	7 "
"	under	1.8	2.2 "	1 "
		average.	max.	min.
	length	4.89	5.40	4.20
	width	2.79	3.00	2.60

d) Percentage of Shinziromai.——2.8%

e) Depth of longitudinal furrow. (μ)

average	max.	min.
47.49	69.20	17.80

f) Specific gravity.——1.389

g) Saccharifying quality. — 39.23 %

h) Hardness. (kilo)

under 3.75	5 grains.
3.75—5.63	34 "
5.63—7.50	11 "
7.50—9.38	—
above 9.38	—

average.	max.	min.
4.74	6.28	3.00

i) Volume of 100g.——128.5c.c.

j) Weight of 1,000 grains. 21.9g.

m) Thickness of bran layer. (μ)

average.	max.	min.
44.97	67.50	36.0

n) Absorption of water.

time steeped	water absorbed.	% absorbed.
1 h.	2.78	5.56
3	5.30	10.60
21	9.90	19.80

o) Depth of embryo cavity.

average.	max	min.
0.27	0.29	0.25

p) Chemical composition.—

		unhydrous.
Water	14.89	—
D. R. sugar	3.12	3.67
Dextrin	3.00	3.52
Starch	69.72	81.92
Crude fat	1 07	1.25
" fibre	0.84	0.99
" protein	7.06	8 29
Ash	1.20	1 41
Phosphoric acid	0 37	0 43

1916 Production.

α) Husked rice unsuitable for the Saké brewing. 4 (I—IV) varieties.

I) *Production of Fukui prefecture.*

a) Percentage of full grown grains. 92.7 %

b) External appearance and luster.——Straw yellow waxy luster, grains were large and fat.

c) Size of grains. (m.m.)

thickness	above	2 2	69 70 g	35 grains
"	"	2 0	24 70 "	12 "
"	"	1 8	5 10 "	3 "
"	under	1 8	0 30 "	—
		average	max	min
	length	5.25	5 60	4 80
	width	3.01	3 20	2 60

d) Percentage of Shinzuomai.- —71.0%

e) Depth of longitudinal furrow. (μ)

average	max.	min
52 94	86 50	29 41

f) Specific gravity. 1.404.

g) Saccharifying quality. —37.95%

h) Hardness. (kilo)

under 3 75 kilo		4 grains
3.75—5 63		49 "
5 63—7 50		33 "
7.50—9 38		11 "
above 9.38		3 "
average	max.	min.
5.83	10 58	3 19

i) Volume of 100g. 122.0c.c.

j) Weight of 1,000 grains.——26.10g.

m) Thickness of bran layer. (μ)

average	max.	min.
52 49	72 0	33.75

n) Absorption of water.

time steeped.	water absorbed.	% absorbed.
1 h.	2.10	4.80
3	5 45	10.90
24	11.85	23.70

o) Depth of embryo cavity.

average.	max.	min.
0 23	0.28	0.19

p) Chemical compositions.—

		unhydrous.
Water	12.56	—
D. R. sugar	2.10	2.74
Dextrin	2.13	2.77
Starch	70.65	80.80
Crude fat	2 23	2 55
" fibre	1 04	1.18
" protein	6.70	7.66
Ash	1.26	1.44
Phosphoric	0 58	0.66

II) *Production of Shiga prefecture.*

a) Percentage of full grown grains. 81.65%

b) External appearance and luster. —Straw brown yellow colour, no luster, grains were fat and middle size, impurities were tolerably abundant.

c) Size of grains. (m.m.)

thickness above	2 2	42.70 g.	21 grains.
" "	2 0	38.10 "	19 "
" "	1 8	16.80 "	9 "
" under	1.8	2.2 "	1 "

	average.	max.	min.
length	5.10	5.50	4.50
width	2 92	3.10	2.50

d) Percentage of Shinziromai. 8.4%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
51.97	91 69	34.60

f) Specific gravity.——1.404.

g) Saccharifying quality. -- 31.65%

h) Hardness. (kilo)

under 3.75	— grains.
3 75—5.63	12 "
5.63—7.50	49 "
7.50—9.38	37 "
above 9.38	2 "

average.	max.	min.
7.05	10.23	4.24

i) Volume of 100g.——125.0c.c.

j) Weight of 1,000 grains.——23.75g.

m) Thickness of bran layer. (μ)

average.	max.	min.
56.23	67.50	38.70

n) Absorption of water.

time steeped.	water absorbed.	% absorbed.
1 h.	3.000	6.00
3	6.450	12 90
24	12.420	24.84

o) Depth of embryo cavity.

average.	max.	min.
0.22	0 29	0.13

p) Chemical composition.—

		unhydrous.
Water	12.14	—
D R. sugar	6.70	0.80
Dextrin	0.99	1.12
Starch	74 56	84.86
Crude fat	2.23	2.54
〃 fibre	1.13	1.29
〃 protein	7 15	8.14
Ash	1.45	1.65
Phosphoric acid	0.37	0.12

III) *Production of Ishikawa prefecture.*

a) Percentage of full grown grains.——90.0%.

b) External appearance and luster.——Dense straw yellow colour, no luster, grain were fat and middle size, impurities were tolerably abundant.

c) Size of grains. (m.m.)

thickness above	2 2	79.10 g	40 grains.
〃 〃	2.0	16.30 〃	8 〃
〃 〃	1.8	3 70 〃	2 〃
〃 under	1.8	0.70 〃	—

	average.	max.	min.
length	5.16	5.50	4.70
width	2.92	3.20	2.60

d) Percentage of Shinziromai.——2.2%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
56.48	86.50	34.60

f) Specific gravity.——1.399

g) Saccharifying quality.——43.49%.

h) Hardness. (kilo)

under. 3.75		— grains.
3.75—5 63		31
5.63—7.50		37
7.50—9.38		23
above 9.38		9
average.	max.	min.
6.82	10.43	3.84

i) Volume of 100g.——125.5c.c.

j) Weight of 1,000 grains.——25.35g.

m) Thickness of bran layer. (μ)

average.	max.	min.
58.43	94.50	34.65

n) Absorption of water.

time steeped.	water absorbed.	% abosorbed.
1 h.	3.12	6.24
3	6.75	13.50
24	12.40	24.80

o) Depth of embryo cavity.

average.	max.	min.
0.24	0.27	0.18

p) Chemical composition. —

		unhydrous.
Water	12.05	—
D. R. sugar	2.86	3.26
Dextrin	0.70	0.79
Starch	73.04	83.05
Crude fat	2.17	2.81
" fibre	1.16	1.32
" protein	7.15	8.13
Ash	1.20	1.36
Phosphoric acid	0.31	0.38

IV) *Production of Shizuoka prefecture.*

a) Percentage of full grown grains.——82.1%

b) External appearance and luster.——Greyish brown straw yellowish colour, no luster, grains were not fat and middle size, impurities abundant.

c) Size of grains. (m.m.)

thickness	above	2.2	46.90 g.	21 grains.
"	"	2.0	36.10 "	18 "
"	"	1.8	14.20 "	7 "
"	under	1.8	2.50 "	1 "
		average.	max.	min.
	length	5.11	5.60	4.50
	width	2.94	3.20	2.60

d) Percentage of Shinziromai.——18.8%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
54.51	87.50	17.50

f) Specific gravity.——1.399

g) Saccharifying quality.——43.22%

h) Hardness. (kilo)

under 3.75	1 grains.
3.75—5.63	36 〃
5.63—7.50	49 〃
7.50—9.38	13 〃
above 9.38	1 〃

average.	max.	min
6.03	9.56	3.69

i) Volume of 100g.——128.0c.c.

j) Weight of 1,000 grains.——24.0g.

m) Thickness of bran layer. (μ)

average.	max.	min.
48.16	60.75	37.35

n) Absorption of water.

time steeped.	water absorbed.	% absorbed.
1 h.	3 05	6.1
3	6.00	12.0
24	11.15	22.30

o) Depth of embryo cavity.

average.	max	min.
0.25	0.30	0.20

p) Chemical composition.—

		unhydrous.
Water	13.73	—
D. R. sugar	2.13	2.47
Dextrin	1.74	2.01
Starch	69.72	80.71
Crude fat	2.06	2 39
〃 fibre	1.19	1.38
〃 protein	8.22	9.52
Ash	1.26	1.46
Phosphoric acid	0.37	0.43

1916 Production.

β) Polished rice, suitable for the Saké brewing. 6 (A—F) varieties.

A) *Production of Okayama prefecture.*

a) Percentage of full grown grains.——84.5%

b) External appearance and luster.——White glassy luster, grains were large and fat, broken grains were abundant.

c) Size of grains. (m.m.)

thickness	above	2.2	35 5 g	18 grains
//	//	2.0	4 3.2 //	22 //
//	//	1 8	18.2 //	9 //
//	under	1 8	2 8 //	1 //

	average	max.	min.
length	5 22	5 50	4 8
width	2 97	3 15	2.1

d) Percentage of Shinzionmai. —57.2 %

e) Depth of longitudinal furrow. (μ)

average	max	min.
39 44	51 9	17 3

f) Specific gravity.— 1.439

g) Saccharifying quality.——33.28%

h) Hardness. (kilo)

under 3 75	41 grains
3 75—5.63	38 //
5 63—7 50	19 //
7 50—9 38	2 //
above 9 38	—

average	max	min
4 48	11 63	2 61

i) Volume of 100g. 117.5c.c.

j) Weight of 1,000 grains —23.8g.

n) Absorption of water.

time steeped	water absorbed	% absorbed
30 m	10 30 g	20 60
2 h	11 87 //	23 74

p) Chemical composition :—

		unhydrous
Water	13 31	—
D. R sugar	1 07	1 24
Dextrin	3 07	3 54
Starch	76 61	88 37
Crude fat	0 28	0 33
// fibre	0 49	0 57
// protein	5 98	6.89
Ash	0 36	0 42
Phosphoric acid	0 13	0 15

B) *Production of Okayama prefecture.*

a) Percentage of full grown grains.—— 93.54%

b) External appearance and luster.——Same as before.

c) Size of grains. (m.m.)

thickness	above	2 2	50.90 g	25 grains
//	//	2.0	38.8 //	19 //
//	//	1.8	9 0 //	5 //
//	under	1 8	1 0 //	1 //

	average.	max.	min.
length	5.16	5.50	4.40
width	2.92	3.10	2.50

d) Percentage of Shinziromai.——69.5%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
32.87	51.90	17.30

f) Specific gravity.——1.444

g) Saccharifying quality.——31.58%

h) Hardness. (kilo)

under 3.75	54 grains.
3.75—5.63	39 〃
5.63—7.50	7 〃
7 50—9.38	—
above 6.38	—

average.	max.	min.
3.80	6.30	2.25

i) Volume of 100g.——118.0c.c.

j) Weight of 1,000 grains.——24.5g.

n) Absorption of water.

time steeped.	water absorbed	% absorbed.
30 m.	10.70 g.	21.4
2 h.	11.65 〃	23.3

p) Chemical composition :——

		unhydrous.
Water	12.71	—
D. R. sugar	0.77	0.88
Dextrin	2.99	3.42
Starch	76.64	87.79
Crude fat	0.30	0.35
〃 fibre	0.49	0.56
〃 protein	5.98	6.85
Ash	0.38	0.44
Phosphoric acid	0.11	0.12

C) *Production of Okayama prefecture.*

a) Percentage of full grown grains.— —92.65%

b) External appearance and luster.——Same as before.

c) Size of grains. (m.m.)

thickness above	2.2	47.10 g.	24 grains.
〃 〃	2.0	40.10 〃	20 〃
〃 〃	1.8	11.0 〃	5 〃
〃 under	1.8	11.4 〃	1 〃

	average.	max.	min.
length	5.02	5.60	4.6
width	9.92	3.10	2.5

d) Percentage of Shinziromai.——61.80%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
31.77	46.71	17.30

f) Specific gravity.——1.439%

g) Saccharifying quality.——26.50%

h) Hardness. (kilo)

under 3 75	48 grains.
3 75—5 63	45 〃
5.63—7.50	7 〃
7.50—9.38	—
above 9.38	—

average	max.	min.
3 85	7.03	2.25

i) Volume of 100g. — 118.0c.c.

j) Weight of 1,000 grains.——24.0g.

n) Absorption of water.

time steeped.	water absorbed	% absorbed.
30 m.	9.40 g.	18 8
2 h.	10 95 〃	21.9

p) Chemical composition :—

		unhydrous.
Water	13.89	—
D. R. ugar	0 85	0.94
Dextrin	2 04	2.37
Starch	76 68	89.16
Crude fat	0 39	0.45
〃 fibre	0.57	0.66
〃 protein	5 81	6.75
Ash	0 42	0.49
Phosphoric acid	0 16	0.19

D) *Production of Miye prefecture.*

a) Percentage of full grown grains.——84.6%

b) External appearance and luster. — Slightly yellowish white glassy luster, grains were fat and middle size, broken grains were perceived.

c) Size of grains. (m.m.)

thickness above	2.2	14 90 g	8 grains.
〃 〃	2.0	38.50 〃	20 〃
〃 〃	1.8	36.20 〃	18 〃
〃 〃	1 6	6 30 〃	3 〃
〃 under	1.6	2 30 〃	1 〃

	average.	max	min.
length	5.08	5.60	4.6
width	2.82	3.00	2.4

d) Percentage of Shinziromai.——53.6%

e) Depth of longitudinal furrow. (μ)

7.50—9.38		—
above 9.38		—
average.	max.	min.
4.84	6.84	2.81

i) Volume of 100g.——125.0c.c.

j) Weight of 1,000 grains.——22.8g.

n) Absorption of water.

time steeped.	water absorbed.	% absorbed
30 m.	4.98 g.	9 96
2 h.	8.98 "	17.36

p) Chemical composition :—

		unhydrous.
Water	13.82	—
D. R. sugar	1.34	1 56
Dextrin	2.62	3.04
Starch	75.39	87.47
Crude fat	0.38	0.45
" fibre	0.21	0 24
" protein	7.60	8.81
Ash	0.77	0.89
Phosphoric acid	0 16	0.19

1916 Production.

β') Polished rice, unsuitable for the Saké brewing. 6 (I—VI) varieties.

I) *Production of Hiroshima prefecture.*

a) Percentage of full grown grains.——91.3%

b) External appearance and luster.——Slightly greyish white colour, grains were fat and middle size.

c) Size of grains. (m.m.)

thickness above	2.2	44.90 g.	22 grains.
" "	2.0	37.50 "	19 "
" "	1.8	15.30 "	8 "
" under	1.8	1.70 "	1 "
	average.	max.	min.
length	5.12	5.60	4.35
width	2.95	3 20	2 75

d) Percentage of Shinziromai.——41.2%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
36 07	51.90	17.30

f) Specific gravity.——1.434

g) Saccharifying quality.——36.78%

h) Hardness. (kilo)

under 3.75	10 grains.
3.75—5.63	36 〃
5.63—7.50	3 〃
7.50—9.38	1 〃
above 9.38	—

average.	max.	min
4.44	7.53	2.74

i) Volume of 100g.— - 124.0c.c.

j) Weight of 1,000 grains.——22.3g.

n) Absorption of water.

time steeped.	water absorbed.	% absorbed.
30 m	8.13 g.	16.26
2 h	10.05 〃	20.10

p) Chemical composition :—

		unhydrous.
Water	13.36	—
D. R sugar.	0.57	0.65
Dextrin	1.52	1.76
Starch	77.35	89.27
Crude fat	0.37	0.42
〃 fibre	0.40	0.46
〃 protein	6.34	7.32
Ash	0.68	0.78
Phosphoric acid	0.15	0.17

II) *Production of Shizuoka prefecture.*

a) Percentage of full grown grains.——85.65%

b) External appearance and luster.— —Nearly same as before.

c) Size of grains. (m.m.)

thickness above	2.2	25.0 g.	13 grains.
〃 〃	2.0	45.9 〃	23 〃
〃 〃	1.8	25.7 〃	13 〃
〃 〃	1.6	2.5 〃	1 〃
〃 under	1.6	0.5 〃	—

	average.	max.	min.
length	4.93	5.40	4.20
width	2.84	3.10	2.30

d) Percentage of Shinziromai.——23.2%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
41.69	69.20	8.65

f) Specific gravity.——1.439

g) Saccharifying quality.——31.85

h) Hardness. (kilo)

under 3.75	27 grains.
3.75—5.63	50 〃

5 63—7.50	22 〃
7.50—9.38	1 〃
above 9.38	—

average.	max.	min.
4.63	7.93	2.27

i) Volume of 100g.——125.0c.c.

j) Weight of 1,000 grains.——21.7g.

n) Absorption of water.

time steeped.	water absorbed	% absorbed.
30 m.	6.22 g.	12.44
2 h.	9 85 〃	19.70

p) Chemical composition :—

		unhydrous.
Water	13.21	—
D R. sugar	1.50	1 73
Dextrin	3.43	3.96
Starch	72.12	83 10
Crude fat	0 77	0 89
〃 fibre	0.39	0.45
〃 protein	7 86	9.05
Ash	0 85	0.87
Phosphoric acid	0.18	0 21

III) *Production of Kagawa prefecture.*

a) Percentage of full grains.——94.4%

b) External appearance and luster. ——Brownish yellow colour, grains were not fat and middle size.

c) Size of grains. (m.m.)

thickness above	2.2	10 10 g.	5 grains.
〃 〃	2 0	47.60 〃	24 〃
〃 〃	1.8	37.20 〃	19 〃
〃 under	1.8	4 50 〃	2 〃

	average.	max.	min.
length	4.83	5 30	4 30
width	2.72	2.90	2.50

d) Percentage of Shinziromai.——4.8%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
38 41	69.20	17.30

f) Specific gravity.——1.434

g) Saccharifying quality.——27.45%

h) Hardness. (kilo)

under 3.75	8 grains
3.75—5.63	22 〃
5 63—7.50	10 〃
7.50—9.38	10 〃
above 9.38	—

average.	max.	min.
5.57	8.93	3.00

i) Volume of 100g.——124.0c.c.

j) Weight of 1,000 grains.——19.3g.

n) Absorption of water.

time steeped.	water absorbed.	% absorbed.
30 m.	7.92 g.	15.84
2 h.	10.80 〃	21.60

p) Chemical composition .—

		unhydrous.
Water	12.96	—
D. R. sugar	0.90	1.03
Dextrin	1.27	1.46
Starch	77.31	88 85
Crude fat	0.89	1.02
〃 fibre	0.80	0.92
〃 protein	6.62	7.48
Ash	0.65	0.74
Phosphoric acid	0.24	0 27

IV) *Production of Kagawa prefecture.*

a) Percentage of full grown grains.——94.6%

b) External appearance and luster.——Nearly same as before.

c) Size of grains. (m.m.)

thickness above	2 2	10.80 g.	5 grains.
〃 〃	2 0	45.70 〃	23 〃
〃 〃	1.8	39 00 〃	20 〃
〃 under	1.8	4.20 〃	2 〃
	average.	max.	min.
length	4.95	5.15	4.60
width	2.83	2 95	2.65

d) Percentage of Shinziromai.——4.8%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
35.98	69.20	17.30

f) Specific gravity.——1.429

g) Saccharifying quality.——32.71%

h) Hardness. (kilo)

under 3.75	28 grains.
3.75—5.63	19 〃
5.63—7.50	3 〃
7.50—9.38	— 〃
above 9.38	—

average.	max.	min.
3.90	6.56	2.63

i) Volume of 100g.——123.5c.c.

j) Weight of 1,000 grains.——19.3g.

n) Absorption of water.

time steeped.	water absorbed.	% absorbed.
30 m	7.65 g.	15 30
2 h	10.47 〃	20.94

p) Chemical composition :—

		unhydrous
Water	13.62	—
D. R. sugar	0.64	0.75
Dextrin	0.67	0 78
Starch	77.79	90.06
Crude fat	0.88	1.01
〃 fibre	0.27	0.31
〃 protein	6.70	8.00
Ash	0.61	0.71
Phosphoric acid	0.21	0.24

V) *Production of Akita prefecture.*

a) Percentage of full grown grains.——96.19%

b) External appearance and luster.——Somewhat brown straw colour, grains were fat and middle size.

c) Size of grains. (m.m.)

thickness above	2.2	65 20 g.	33 grains.
〃 〃	2.0	25.00 〃	12 〃
〃 〃	1.8	8.40 〃	4 〃
〃 under	1 8	1 00 〃	1 〃
	average.	max	min.
length	4.65	5 15	4.20
width	3.00	3.35	2 65

d) Percentage of Shinziromai.——30.8%

e) Depth of longitudinal furrow. (μ)

average.	max.	min
50 34	86 50	17.30

f) Specific gravity. 1.429

g) Saccharifying quality.——37.11%

h) Hardness. (kilo)

under 3.75		25 grains.
3.75—5.63		21 〃
5.63—7.50		4 〃
7.50—9.38		—
above 9.38		—
average.	max.	min.
3 84	6.15	2.25

i) Volume of 100g.- — 123.5c.c.

j) Weight of 1,000 grains.——22.0g.

n) Absorption of water.

time steeped	water absorbed.	% absorbed
30 m.	5.40	10.80
2 h.	8.50	17.00

p) Chemical composition :—

		unhydrous
Water	14.21	—
D. R. sugar	1 24	1.45
Dextrin	1.29	1.50
Starch	76.34	88.98
Crude fat	0.25	0.30
〃 fibre	0.26	0.30
〃 protein	7 00	8.16
Ash	0 49	0.57
Phosphoric acid	0 15	0.17

VI) *Production of Yamagata prefecture.*

a) Percentage of full grown grains.——88.0%

b) External appearance and luster.——Greyish white colour, grains were not fat and middle size.

c) Size of grains. (m.m.)

thickness above	2.2	30.80 g.	16 grains.
〃 〃	2 0	40.60 〃	20 〃
〃 〃	1 8	23 90 〃	12 〃
〃 under	1 8	4 00 〃	2 〃
	average	max	min.
length	4.93	5.40	4.45
width	2 87	3.10	2.45

d) Percentage of Shinziromai. - - 13.6%

e) Depth of longitudinal furrow. (μ)

average	max	min.
39.01	69.20	17 30

f) Specific gravity.——1.434

g) Saccharifying quality.— 29.12%

h) Hardness. (kilo)

under 3 75		8 grains
3 75—5 63		35 〃
5 63—7.50		7 〃
7 50—9 38		—
above 9 38		—
average.	max.	min.
4.61	6.19	3 00

i) Volume of 100 g.——126.0c.c.

j) Weight of 1,000 grains. ——20.55g.

n) Absorption of water.

time steeped.	water absorbed.	% absorbed.
30 m.	7.62 g.	15.24
2 h.	8.88 〃	17.76

TABLE I. 6 Husked rice.

Suitable A—R. Unsuitable I—IV.

	% of full grown grain.	External appearance and luster.	% of Shinziromai	Depth of longitudinal furrow.(μ)	Specific gravity.	Saccharifying quality. (%)	Hardness. (kilo)	Absorption of water. (%)	Volume of 100g. (c.c.)	Weight of 1,000grain. (g.)	Thickness of bran layer.(μ)	Depth of embryo cavity	Water	D. R. sugar	Dextrin	Starch	Crude fat	Crude fibre	Crude protein	Ash	P_2O_5
A	91.0	1st Class	55.64	52.76	1.404	31.98	5.41	22.94	127.5	26.22	43.38	0.27	13.22	2.61	2.32	83.17	2.03	1.42	7.72	1.34	0.43
B	94.1	do	79.10	51.63	do	35.41	4.39	21.40	122.0	26.97	42.65	0.25	13.99	3.41	1.90	81.72	2.15	1.15	8.00	1.35	0.41
C	91.95	do	64.30	46.74	1.389	33.80	5.55	20.60	125.0	26.95	41.36	0.26	13.56	1.80	1.59	84.05	2.47	1.17	8.47	1.41	0.43
D	92.3	do	49.92	61.95	1.399	29.93	6.28	24 04	124.0	24.70	41.48	0.26	12.64	2.77	2.20	81.47	2.51	1.17	7.87	1.46	0.69
E	88.05	do	79.70	55.88	do	32 83	6.68	24.54	124.0	24.20	43.97	0.29	12.37	2.88	2.33	80.33	2.57	1.18	9.18	1.62	0.49
F	96.7	do	83.00	58.39	1.406	32.19	5.64	20.60	119.0	25.10	45.72	0.25	12.88	3.63	1.42	81.03	2.72	1.14	7.99	1.42	0.41
G	83.8	do	11.70	60.98	1.384	30.29	6.36	21.14	126.0	23.90	45.74	0.26	13.15	2.38	2.57	82.67	2.39	1.30	8.25	1.56	0.45
H	87.2	2nd Cl.	27.70	58.39	1.394	24.93	5.23	21.94	129.0	24.45	46.02	0.26	13.86	2.80	1.55	83.03	2.40	1.39	7.47	1.54	0.63
I	92.6	1st Cl.	79.12	68.16	1.399	37.09	5.17	21.54	123.5	26.21	46.31	0.28	13.59	2.62	1.36	82.79	2.27	1.18	7.86	1.29	0.41
J	92.4	2nd Cl.	8.84	58.13	1.389	38.11	5.88	22.00	128.5	23.44	54.61	0.25	13.97	2.60	2.13	81.13	2.41	1.15	8.73	1.49	0.47
K	85.26	1st Cl.	63.04	50.69	1.406	36.16	6.03	23.70	124.5	25.41	45.63	0.24	13.04	1.37	1.42	82.86	2.43	1.35	8.49	1.40	0.39
L	69.30	3rd Cl.	3.20	61.95	1.389	32.68	5.79	20.64	129.0	26.10	52.18	0.26	16.09	3.18	2.60	81.54	0.73	1.17	10.22	1.79	0.51
M	93.06	1st Cl.	3.60	42.65	1.394	27.21	5.82	20.40	128.5	20.30	42·49	0.23	14.09	5.98	2.28	79.64	1.94	1.01	9.04	1.52	0.44
N	75 40	3rd Cl.	4.40	59.43	1.389	38.21	5.46	22.30	133.5	21.55	43 75	0.26	14.97	2.51	2.38	82.20	2.23	0.99	8.30	1.47	0.43
O	89.60	2nd Cl.	14.00	54.24	do	20.15	5.42	21.40	129.5	23.50	46.05	0.29	14.36	3.97	2.62	82.92	2.07	1.40	7.41	1.51	0.54
P	87.20	do	4.20	47.49	do	23.37	5.32	20.30	130.0	24.70	48.56	0.29	15.57	2.59	2.59	81.35	0.81	1.33	9.63	1.61	0.51
Q	89.64	do	0.40	40.48	1.394	39.49	5.27	21.90	128.5	21.60	44.64	0.28	16.23	3.41	2.77	81.14	0.86	1.17	8.85	1.64	0.52
R	85.50	do	2.80	47.49	1.389	39.23	4.74	19.80	128.5	21.90	44.97	0.27	14.89	3.67	3.52	81.92	1.25	0.99	8.29	1.41	0.43
I	92.70	1st Cl.	74.00	52.94	1.404	37.95	5.82	23.70	122.0	26.10	52.49	0.23	12.56	2.74	2.77	80.80	2.55	1.18	7.66	1.44	0.66
II	81.65	2nd Cl.	8.40	51.97	do	31.65	7.05	24.84	125 0	23.75	56.23	0.22	12.14	0.80	1.12	84.86	2.54	1.29	8.14	1.65	0.42
III	90.00	do	2.20	56.49	1.399	43.49	6.82	24.80	125.5	25.35	58.43	0.24	12.05	3.26	0.79	83.05	2.81	1.32	8.13	1.36	0.38
IV	82.10	do	18.80	54.51	do	43.22	6.03	23.30	128.0	24.00	48.16	0.25	13.73	2.47	2.01	80.71	2.39	1.38	9.52	1.46	0.43

TABLE II. 1916 Polished rice.

Suitable A—F. Unsuitable I—VI.

	% of full grown grain	External appearance and luster.	% of Shinziromai	Depth of longitudinal furrow (μ)	Specific gravity	Saccharifying quality. (%)	Hardness. (kilo)	Absorption of water (%)	Volume of 100g. (c.c.)	Weight of 1,000grains (g.)	Water	D. R. sugar	Dextrin	Starch	Crude fat	Crude fibre	Crude protein	Ash	P_2O_5
A	84.5	1st Class	57.2	39.44	1.44	33.28	4.48	23 74	117.5	23.8	13 31	1.24	3.54	88 37	0.33	0.57	6.89	0.42	0.15
B	93 54	do	69.5	32.87	1.44	31.58	3 80	23.30	118.0	24.5	12.71	0.87	3.42	87.79	0.35	0.56	6.85	0.44	0.12
C	92.65	do	61.8	34.77	1.44	26.50	3.85	21.90	do	24.0	13.89	0 94	2.37	89.16	0.45	0.66	6.75	0.49	0.19
D	84.60	2nd Cl	53.6	38.93	do	30.73	4 17	20 80	123.0	21.7	13.24	1.86	3.49	85.09	0.69	0.76	6.89	0.85	0.16
E	94.45	do	14.4	41.87	1.43	37.69	5.00	19.16	122.5	22.1	13.56	0.77	1.97	87.60	0.19	0 31	7.96	0.57	0.14
F	93.80	do	10.4	45.07	do	34.01	1.88	17 36	125.0	22 8	13 82	1.56	3.04	87.47	0.45	0.24	8.81	0.89	0.19
I	91.30	2nd Cl.	41.2	36.07	1.43	36.78	4.44	20.10	124.0	22.3	13.36	0.65	1.76	89.27	0.42	0.46	7.32	0.78	0.17
II	85.65	3rd Cl.	23.2	41.69	1.44	31·85	4.63	19.70	125.0	21.7	13.21	1.73	3.96	83.10	0.89	0.45	9.05	0.87	0.21
III	64.40	do	4.8	38.41	1.43	27.45	5 57	21.60	124.0	19.3	12.96	1.03	1.46	88.85	1.02	0.92	7.48	0.74	0.27
IV	94.60	do	4.8	35.98	1.43	32.74	3.90	20.94	123.5	do	13.62	0.75	0.78	90.06	1.01	0.31	8.00	0.71	0.24
V	96.19	do	30.8	50.34	do	37.11	3.84	17.00	do	22.0	14.21	1.45	1.30	88.98	0.30	0.30	8.16	0.57	0.17
VI	85.00	do	13.6	39.01	1.43	29.12	4.61	17.76	126.0	22.55	14.67	1.44	1.45	88.13	0.49	0.63	6.54	0.91	0.19

p) Chemical composition :—

		unhydrous.
Water	14.67	—
D. R. sugar	1 23	1.44
Dextrin	1.24	1.45
Starch	75 20	88.13
Crude fat	0 42	0.49
〃 fibre	0 54	0.63
〃 protein	6.34	6.54
Ash	0.78	0.91
Phosphoric acid	0.16	0.19

Summary of the 1916 production.

Percentage of full grown grains and Shinziromai, weight of 1,000 grains, and the sum of starch, dextrin and sugar, are found to be greater in the suitable materials for the Saké brewing, whilst volume of 100g., thickness of bran layer, and the conetnts of crude fat, crude protein, crude fibre, ash and phosphoric acid, are found to be smaller. Specific gravity, sacchaiifying quality, hardness, water and absorption of water were found to be moderate. The external appearance and luster should be fine. Seven varieties (L–R) produced in the districts rather unfitted for rice plantation were omitted from the judgment since these were locally regarded as the suitable materials for the Saké brewing, but not in the general opinion.

1917 Production.

α) Husked rice, suitable for the Saké brewing. 20 (A–T) varieties.

A) *Production of Okayama prefecture.*

a) Percentage of full grown grains.——90.33%

b) External appearance and luster.——Light straw yellow waxy luster, grains were fat and large, impurities were rare.

c) Size of grains. (m.m.)

thickness above	2 2	86 97 g.	44 grains.
〃 〃	2 0	10.92 〃	5 〃
〃 〃	1.8	1.65 〃	1 〃
〃 under	1.8	0 45 〃	—
	average.	max.	min.
length	5.49	5.85	5.15
width	3.14	3.30	2.90

d) Percentage of Shinziromai.——95.24%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
41 52	69.20	17.30

f) Specific gravity.——1.399

g) Saccharifying quality.——27.30%

h) Hardness. (kilo)

under 3.75	8 grains.
3.75—5.63	36 "
5.63—7.50	6 "
7.50—9.38	—
above 9.38	—

average.	max.	min.
4.54	6.63	2.53

i) Volume of 100g.——124.0c.c.

j) Weight of 1,000 grains.——28.23g.

k) Volume of 1,000 grains.——20.25c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
50.27	59.40	41.63

n) Absorption of water.

time steeped.	% absorbed.
24 h.	22.30

o) Depth of embryo cavity :—

average.	max.	min.
0.24	0.29	0.21

p) Chemical composition :—

		unhydrous.
Water	12.88	—
D. R. sugar	0.96	1.11
Starch	73.16	84.42
Crude fat	2.31	2.55
" fibre	1.65	1.90
" protein	7.96	9.19
Ash	1.19	1.37
Phosphoric acid	0.44	0.51

B) *Production of Okayama prefecture.*

a) Percentage of full grown grains. 90.48%

b) External appearance and luster.——Nearly same as A).

c) Size of grains. (m.m.)

thickness above	2.2	70.95 g.	36 grains.
" "	2.0	24.07 "	12 "
" "	1.8	4.48 "	2 "
" "	1.6	0.25 "	—
" under	1.6	0.20 "	—

	average.	max.	min.
length	5.43	5.85	4.95
width	3.02	3.25	2.80

d) Percentage of Shinziromai.——58.0%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
31.57	51.90	17.30

f) Specific gravity.——1.399

g) Saccharifying quality.——30.04%

n) Hardness. (kilo)

under 3.75	2 grains.
3.75—5.63	28 〃
5.63—7.50	20 〃
7.50—9.38	—
above 9.33	—

average.	max.	min.
5.32	7.28	3.19

i) Volume of 100g.——122.0c.c.

j) Weight of 1,000 grains.——26.45g.

k) Volume of 1,000 grains.——18.9c.c.

l) Phytin.——0.19%

m) Thickness of bran layer. (μ)

average.	max	min.
45.60	49.28	40.50

n) Absorption of water.

time steeped.	% absorbed.
24 h.	23.22

o) Depth of embryo cavity :—

average.	max.	min.
0.25	0.31	0.19

p) Chemical composition :—

		unhydrous.
Water	13.07	—
D. R. sugar	0.92	1.08
Starch	73.10	85.23
Crude fat	1.91	2.23
〃 fibre	1.49	1 73
〃 protein	7.11	8 28
Ash	1.23	1.44
Phosphoric acid	0.50	0.58

C) *Production of Niigata prefecture.*

a) Percentage of full grown grains.——95.0%

b) External appearance and luster.——Brown straw yellow colour, destitute of luster, grains were not fat.

c) Size of grains. (m.m.)

thickness above	2.2	49.11 g.	25 grains.
〃 〃	2.0	40.85 〃	20 〃
〃 〃	1.8	9.60 〃	5 〃

〃	〃	1.6	0.27 〃	—
〃	under	1.6	0.06 〃	—
		average.	max.	min.
	length	5.27	5.80	4.90
	width	2.97	3.15	2.60

d) Percentage of Shinziromai.——12.5%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
41.74	69.20	17.30

f) Specific gravity.——1.399

g) Saccharifying quality.——30.15%

h) Hardness. (kilo)

under 3.75	19 grains.
3.75—5.63	31 〃
5.63—7.50	—
7.50—9.38	—
above 9.38	—

average.	max.	min.
4.10	5.44	2.81

i) Volume of 100g.——131.0c.c.

j) Weight of 1,000 grains.——24.22g.

k) Volume of 1,000 grains.——16.6c.c.

m) Thickness of bran layer. (μ)

average.	max	min.
45.77	53.10	37.80

n) Absorption of water.

time steeped.	% absorbed.
24 h.	19.1

o) Depth of embryo cavity :—

average.	max.	min.
0.23	0.27	0.19

p) Chemical composition :—

		unhydrous.
Water	14.24	—
D. R. sugar	1.11	1.30
Starch	72.22	84.35
Crude fat	2.26	2.64
〃 fibre	0.99	1.15
〃 protein	7.88	9.20
Ash	1.18	1.38
Phosphoric acid	0.44	0.51

D) *Production of Hyogo prefecture.*

a) Percentage of full grown grains.——89.86%

b) External appearance and luster.——Straw yellow waxy luster, grains were large and fat.

c) Size of grains. (m.m.)

thickness above	2.2	54.29 g.	27 grains.
" "	2.0	33.82 "	17 "
" "	1 8	11 37 "	6 "
" "	1 6	0 42 "	—
" under	1.6	0.10 "	—

	average	max.	min.
length	5.39	5 65	5.05
width	3.08	3 35	2 75

d) Percentage of Shinziromai.——77.0%

e) Depth of longitudinal furrow. (μ)

average.	max	min
67 34	103 80	34.60

f) Specific gravity.——1.409
1.42 (Shinziromai)

g) Saccharifying quality.——30.28

h) Hardness. (kilo)

under 3 75	6 grains.
3 75—5 63	36 "
5 63—7 50	8 "
7 50—9.38	—
above 9 38	—

average	max	min
4 69	6.56	3 38

i) Volume of 100g.——122.0c.c.

j) Weight of 1,000 grains.——25.78g.
28.00g. (Shinziromai)

k) Volume of 1,000 grains.——18.4c.c.
20.3c.c. (Shinziromai)

m) Thickness of bran layer. (μ)

average	max	min.
44 62	49.28	40 28

n) Absorption of water.

time steeped	% absorbed
24 h	21 96

o) Depth of embryo cavity :—

average	max	min.
0 28	0 31	0.24

p) Chemical composition :—

		unhydrous.
Water	13 14	—
D R sugar	0.68	0 79
Starch	74.41	85.72
Crude fat	2 10	2 41

" fibre	1.15	1.32
" protein	7.29	8.40
Ash	1.18	1.36
Phosphoric acid	0.20	0.23

F) *Production of Hyogo prefecture.*

a) Percentage of full grown grains.——88.88%

b) External appearance and luster. —Nearly same as before.

c) Size of grains. (m.m.)

thickness above	2.2	55.72 g.	28 grains.
" "	2.0	33 59 "	17 "
" "	1.8	9.68 "	5 "
" "	1.6	0.63 "	—
" under	1.6	0.05 "	—

	average	max.	min.
length	5.23	5.65	5.00
width	3.13	3.33	3.00

d) Percentage of Shinziromai.——69.64%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
57.18	86.50	25.95

f) Specific gravity. 1.409

g) Saccharifying quality.——32.06%

h) Hardness. (kilo)

under 3.75	12 grains.
3.75—5.63	31 "
5 63—7.50	7 "
7.50—9.38	—
above 9.38	—

average.	max.	min.
4.48	6.56	2.78

i) Volume of 100g.—— 126.5c.c.

j) Weight of 1,000 grains.——25.35g.

k) Volume of 1,000 grains.——18.1c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
44.54	52.88	36.45

n) Absorption of water.

time steeped.	% absorbed.
24 h.	21.6

o) Depth of embryo cavity :—

average.	max.	min.
0.28	0.32	0.22

p) Chemical composition :—

		unhydrous.
Water	13.59	—
D. R. sugar	1.20	1.40
Starch	72.56	84 30
Crude fat	2.10	2.44
" fibre	1.09	1.27
" protein	7.96	9.25
Ash	1.16	1.35
Phosphoric acid	0.42	0.48

F) *Production of Hyogo prefecture.*

a) Percentage of full grown grains.——93.4%

b) External appearance and luster.——Nearly same as before.

c) Size of grains. (m.m)

thickness above	2.2	59.15 g.	30 grains.
" "	2.0	32.11 "	16 "
" "	1.8	8.50 "	4 "
" "	1.6	0 24 "	—
" under	1.6	—	—
	average.	max	min.
length	5.29	5.65	5.00
width	3.15	3.30	2.90

d) Percentage of Shinziromai.——68.0%

e) Depth of longitudinal furrow. (μ)

average	max.	min.
58.60	103.80	34.60

f) Specific gravity.——1.409

g) Saccharifying quality.——26.32%

h) Hardness. (kilo)

under 3.75		17 grains.
3.75—5.63		30 "
5.63—7.50		3 "
7.50—9.38		—
above 9.38		—
average.	max.	min.
4.21	5.68	2.33

i) Volume of 100g.- -123.0c.c.

j) Weight of 1,000 grains.——25.12g.

k) Volume of 1,000 grains.——18.00c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
43.28	50.85	36.90

n) Absorption of water.

time steeped.	% absorbed.
	20.8

o) Depth of embryo cavity :—

average.	max.	min.
0.28	0.33	0.24

p) Chemical composition :—

		unhydrous.
Water	13.31	—
D. R. sugar	1.14	1.31
Starch	73.64	84.79
Crude fat	2.11	2.42
" fibre	1.01	1.16
" protein	7.96	9.17
Ash	1.00	1.03
Phosphoric acid	0.52	0.60

G) *Production of Fukuoka prefecture.*

a) Pecentage of full grown grains.—— 86.38%

b) External appearance and luster.——Brownish straw colour, destitute of luster, grains were not fat and of middle size, impurities were tolerably abundant.

c) Size of grains. (m.m.)

thickness above	2.2	21.51 g.	11 grains.
" "	2.0	40.38 "	20 "
" "	1.8	31.88 "	16 "
" "	1 6	4.39 "	2 "
" under	1.6	1.84 "	1 "
	average.	max.	min.
length	5.15	5.50	4.60
width	3.00	3.25	2.65

d) Percentage of Shinziromai.—— 20.6%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
58.39	78.75	17.30

f) Specific gravity.——1.399

g) Saccharifying quality.——31.26%.

h) Hardness. (kilo)

under 3.75		5 grains.
3.75—5.63		15 "
5.63—7.50		28 "
7.50—9.38		2 "
above 9.38		—
average.	max.	min.
5.71	8.18	3.00

i) Volume of 100g.——129.0c.c.

j) Weight of 1,000 grains.——23.05g.

k) Volume of 1,000 grains.——16.55c.c.

l) Phytin——0.56%

m) Thickness of bran layer. (μ)

average.	max.	min.
44.06	48.38	40.73

n) Absorption of water.

time steeped.	% absorbed.
24 h.	24.46

o) Depth of embryo cavity :—

average.	max.	min.
0.26	0.32	0.18

p) Chemical composition :—

		unhydrous.
Water	12.46	—
D. R. sugar	1.00	1.15
Starch	73.47	84.18
Crude fat	2.44	2.80
" fibre	1.38	1.58
" protein	7.71	8.83
Ash	1.27	1.46
Phosphoric acid	0.54	0.69

H) *Production of Kumamoto prefecture.*

a) Percentage of full grown grains. 89.23%

b) External appearance and luster. - - Nearly same as A).

c) Size of grains. (m.m.)

thickness above	2.2	21.58 g.	11 grains
" "	2.0	47.93 "	24 "
" "	1.8	27.88 "	14 "
" "	1.6	2.25 "	2 "
" under	1.6	0.34 "	—

	average.	max.	min.
length	5.05	5.45	4.60
width	2.93	3.15	2.75

d) Percentage of Shinziromai.——32.4%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
55.14	86.50	17.30

f) Specific gravity.——1.404

g) Saccharifying quality.——34.18%

h) Hardness. (kilo)

under 3.75	3 grains
3.75—5.63	25 "
3.63—7.50	21 "
7.50—9.38	1 "
above 9.38	—

average.	max.	min.
5.35	7.97	2.63

i) Volume of 100g.——121.0c.c.

j) Weight of 1,000 grains.——22.37g.

k) Volume of 1,000 grains.——16.0c.c.
17.1c.c. (Shinziromai)

l) Phytin. 0.44%

m) Thickness of bran layer. (μ)

average.	max.	min.
12.4	47.03	38.48

n) Absorption of water.

time steeped.	% absorbed.
24 h.	23.48

o) Depth of embryo cavity :—

average.	max	min.
0.28	0.34	0.25

p) Chemical composition :—

		unhydrous.
Water	12.53	—
D. R. sugar	1.08	1.23
Starch	73.34	83.91
Crude fat	2.50	2.86
" fibre	1.24	1.41
" protein	8.05	9.21
Ash	1.21	1.38
Phosphoric acid	0.50	0.57

I) *Production of Saga prefecture.*

a) Percentage of full grown grains.——89.63%

b) External appearance and luster.——Nearly same as before.

c) Size of grains. (m.m.)

thickness above	2.2	40.42 g.	20 grains.
" "	2.0	44.21 "	22 "
" "	1.8	14.19 "	7 "
" "	1.6	0.94 "	1 "
" under	1.6	0.18 "	—
	average.	max.	min.
length	5.19	5.55	5.00
width	3.00	3.25	2.75

d) Percentage of Shinziromai.——31.5%

e) Depth of longitudinal furrow. (μ)

average	max.	min.
61.63	95.15	34.60

f) Specific gravity.——1.409

g) Saccharifying quality.——32.07%

h) Hardness. (kilo)

under 3.75	3 grains.
3.75—5.63	21 "
5.63—7 50	25 "
7 50—9.38	1 "
above 9.38	—

average.	max.	min.
5.66	7.54	3.38

i) Volume of 100g. — 125.0c.c.

j) Weight of 1,000 grains.——23.7g.

k) Volume of 1,000 grains. ——16.9c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
42.89	50.85	36.00

n) Absorption of water.

time steeped.	% absorbed.
24 h.	24.08

o) Depth of embryo cavity :—

average	max.	min.
0.27	0.31	0.21

p) Chemical composition :—

		nnhydrous.
Water	12 82	—
D. R. sugar	1.19	1.37
Starch	73.08	83 79
Crude fat	2.43	2.79
" fibre	1.20	1.38
" protein	8 05	9.23
Ash	1.27	1.46
Phosphoric acid	0 53	0.61

J) *Production of Kagawa prefecture.*

a) Percentage of full grown grains.——85.05%

b) External appearance and luster.——Nearly same as G).

c) Size of grains. (m.m.)

thickness above	2.2	41.06 g.	21 grains.
" "	2.0	46.71 "	23 "
" "	1 8	11.37 "	6 "
" "	1.6	0.68 "	—
" under	1 6	0.13 "	—

	average.	max.	min.
length	5.20	5.50	4.75
width,	3.04	3.25	2.85

d) Percentage of Shinziromai.——41.56%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
56.23	95.15	25.95

f) Specific gravity.——1.409

g) Saccharifying quality. —34.36%

h) Hardnesss. (kilo)

under 3.75	2 grains.
3.75—5.63	31 "
5.63—7.50	16 "
7.50—9.38	1 "
above 9.38	—

average.	max.	min.
5.19	7.97	3.19

i) Volume of 100g. — - 126.0c.c.

j) Weight of 1,000 grains.——24.23g.

k) Volume of 1,000 grains.——17.30c.c.

l) Phytin.——0.43%

m) Thickness of bran layer. (μ)

average.	max.	min.
45.88	49.95	42.08

n) Absorption of water.

Time steeped.	% absorbed.
24 h.	25.34

o) Depth of embryo cavity :—

average.	max.	min.
0.27	0.31	0.17

p) Chemical composition :—

Water	12.72	—
D. R. sugar	0.90	1.06
Starch	72.27	84.59
Crude fat	2.39	2.80
" fibre	1.21	1.42
" protein	7.46	8.73
Ash	1.21	1.42
Phosphoric acid	0.53	0.62

K) *Production of Yehime prefecture.*

a) Percentage of full grown grains.—— 87.96%

b) External appearance and luster.——Straw yellow waxy luster, grains were large and fat, impurities were perceptible.

c) Size of grains. (m.m.)

Thickness above	2.2	62.45 g.	31 grains.
" "	2.0	28.17 "	14 "
" "	1.8	8.15 "	4 "
" "	1.6	0.92 "	1 "
" under	1.6	0.19 "	—

	average.	max.	min.
length	5.41	5.90	4.95
width	3.02	3.25	2.70

d) Percentage of Shinziromai——52.52%

e) Depth of longitudinal furrow. (μ)

average	max.	min.
51.47	86.50	17.30

f) Specific gravity.—— 1.399

g) Saccharifying quality. 37.43%

h) Hardness. (kilo)

under 3.75	3 grains
3 75—5 63	29 "
5 63—7.50	18 "
7 50—9 38	—
above 9.38	—

average.	max	min
5.26	7 46	3 30

i) Volume of 100g. 124.0c.c.

j) Weight of 1,000 grains. 25.77g.

k) Volume of 1,000 grains. — 18.3c.c.

l) Phytin. 0.43%

m) Thickness of bran layer. (μ)

average.	max.	min
44.79	49 95	40 73

n) Absorption of water.

time steeped	% absorbed
24 h	21 36

o) Depth of embryo cavity :—

average.	max	min
0 27	0 31	0 23

p) Chemical composition :—

		unhydrous.
Water	13 46	—
D R. sugar	0 83	0.96
Starch	73.04	84.59
Crude fat	2.31	2.68
" fibre	1 04	1.20
" protein	7.96	9.22
Ash	1.16	1.34
Phosphoric acid	0 51	0 59

I.) *Production of Yehime prefecture.*

a) Percentage of full grown grains.——89.48%

b) External appearance and luster.——Nearly same as before.

c) Size of grains. (m.m.)

thickness above		2.2	52.24 g.	26 grains.
〃	〃	2.0	36.25 〃	18 〃
〃	〃	1.8	10.59 〃	5 〃
〃	〃	1.6	0.75 〃	1 〃
〃	under	1.6	0.15 〃	—
		average.	max.	min.
	length	5.44	5.75	5.00
	width	3.03	3.20	2.75

d) Percentage of Shinziromai.——63.28%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
50.60	86.50	34.60

f) Specific gravity. ——1.409

g) Saccharifying quality. 36.17%

h) Hardness. (kilo)

under 3.75	8 grains.
3.75—5.63	23 〃
5.63—7.50	17 〃
7.50—9.38	2 〃
above 9.38	—

average.	max.	min.
5.79	8.94	3.08

i) Volume of 100g. - 124.0c.c.

j) Weight of 1,000 grains. 25.5g.

k) Volume of 1,000 grains.— 18.2c.c.

l) Phytin.- 0.37%

m) Thickness of bran layer. (μ)

average.	max.	min.
44.46	50.18	38.25

n) Absorption of water.

Time steeped.	% absorbed.
24 h.	23.92

o) Depth of embryo cavity :—

average.	max.	min.
0.25	0.32	0.21

p) Chemical composition :—

		unhydrous.
Water	12.51	—
D. R. sugar	1.09	1.25
Starch	73.32	83.91
Crude fat	2.57	2.94
〃 fibre	1.48	1.69
〃 protein	7.71	8.82
Ash	1.21	1.38
Phosphoric acid	0.46	0.53

M) *Production of Fukushima prefecture.*

a) Percentage of full grown grains.——89.4%

b) External appearance and luster.— Brownish straw yellow colour, destitute of luster, grains were not fat.

c) Size of grains. (m.m.)

thickness	above	2.2	56.54 g.	28 grains.
〃	〃	2.0	30 86 〃	15 〃
〃	〃	1.8	11.12 〃	6 〃
〃	〃	1.6	1.09 〃	1 〃
〃	under	1.6	0.34 〃	—
		average	max.	min.
	length	5 03	5.55	4.65
	width	3 01	3 25	2 65

d) Percentage of Shinziromai. 19.04%

e) Depth of longitudinal furrow. (μ)

average	max	min
60 55	103 80	17.30

f) Specific gravity. 1.418

g) Saccharifying quality. 37.53%

h) Hardness. (kilo)

under 3 75		5 grains
3.75—5 63		26 〃
5.63—7.50		19 〃
7 50—9.38		—
above 9 38		—
average	max	min
5 11	7 01	2 70

i) Volume of 100g. 130.0c.c.

j) Weight of 1,000 grains. 24.1g.
25.85g. (Shinziromai)

k) Volume of 1,000 grains. 17.1c.c.
18.35c.c. (Shinziromai)

l) Phytin. 0.49%

m) Thickness of bran layer. (μ)

average	max	min.
45 61	49 95	41.63

n) Absorption of water.

time steeped	% absorbed.
24 h.	21 04

o) Depth of embryo cavity :—

average	max.	min
0.26	0.33	0 20

p) Chemical composition :—

		unhydrous.
Water	13 74	—
D. R. sugar	0.73	0.85
Starch	73.04	85.25
Crude fat	2.10	2.45
" fibre	1.08	1.26
" protein	7.46	8 70
Ash	1 28	1.49
Phosphoric acid	0.49	0.57

N) *Production of Fukushima prefecture.*

a) Percentage of full grown grains. 74.05%

b) External appearance and luster.— Nearly same as M), but impurities were tolerably abundant.

c) Size of grains. (m.m.)

thickness above	2 2	45.61 g.	23 grains.
" "	2.0	26.39 "	13 "
" "	1.8	22.87 "	11 "
" "	1.6	3.40 "	2 "
" under	1.6	1.63 "	1 "
	average	max.	min.
length	5.06	5.40	4.65
width	3.02	3.30	2.70

c) Percentage of Shinziromai. 16.22%

e) Depth of longitudinal furrow. (μ)

average	max.	min.
49.95	86.50	17.30

f) Specific gravity. 1.382

g) Saccharifying quality. 34.88%

h) Hardness. (kilo)

under 3.75		2 grains
3.75—5.63		35 "
5.63—7.50		13 "
7.50—9.38		—
above 9.38		—
average	max.	min.
5.18	6.56	3.56

i) Volume of 100g.--- 132.0c.c.

j) Weight of 1,000 grains. - 23.62g.

k) Volume of 1,000 grains. - 17.1c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
46.20	50.63	42.30

n) Absorption of water.

time steeped.	% absorbed.
24 h.	22.52

o) Depth of embryo cavity :—

average.	max.	min.
0.26	0.32	0.22

p) Chemical composition :—

		unhydrous.
Water	14.54	—
D. R sugar	1.38	1.63
Starch	71.91	84.77
Crude fat	2.14	2.53
" fibre	0.93	1.09
" protein	7.20	8.49
Ash	1.27	1.50
Phosphoric acid	0.46	0.55

O) *Production of Miyagi prefecture.*

a) Percentage of full grown grains. - 86.2%

b) External appearance and luster. - Nearly same as N), but impurities were somewhat rare.

c) Size of grains. (m.m.)

thickness above	2.2	6.72 g.	3 grains.
" "	2.0	24.00 "	12 "
" "	1.8	64.83 "	32 "
" "	1.6	3.16 "	2 "
" under	1.6	1.19 "	1 "

	average.	max.	min.
length	5.00	5.40	4.65
width	2.85	3.00	2.35

d) Percentage of Shinziromai. 9.5%

e) Depth of longitudinai furrow. (μ)

average	max.	min.
55.15	86.50	34.60

f) Specific gravity. 1.394

g) Saccharifying quality. ——28.04%

h) Hardness. (kilo)

under 3.75	7 grains.
3.75—5.63	35 "
5.63—7.50	8 "
7.50—9.38	—
above 9.38	—

average.	max.	min.
4.80	6.56	2.8

i) Volume of 100g. 130.5c.c.

j) Weight of 1,000 grains.——20.47g.

k) Volume of 1,000 grains. —14.7c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
42.74	48.15	35.78

n) Absorption of water.

time steeped.	% absorbed.
24 h.	20.76

o) Depth of embryo cavity :—

average.	max.	min.
0 26	0.34	0.23

p) Chemical composition :—

		unhydrous.
Water	14.07	—
D. R sugar	1.22	1.42
Starch	72.78	84.78
Crude fat	2.22	2.59
" fibre	0 78	0.91
" protein	7.62	8.88
Ash	1.23	1.44
Phosphoric acid	0.55	0.64

P) *Production of Niigata prefecture.*

a) Percentage of full grown grains. 92.42%

b) External appearance and luster. —Straw yellow colour, somewhat destitute of luster, grains were not fat.

c) Size of grains. (m.m.)

thickness above	2.2	31.91 g.	16 grains.
" "	2.0	52.42 "	26 "
" "	1.8	14.48 "	8 "
" "	1.6	0.60 "	—
" under	1.6	0.13 "	—

	average.	max.	min.
length	5.23	5.65	4.90
width	2.96	3.15	2.75

d) Percentage of Shinziromai. — 10.5%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
51.04	69.20	17.30

f) Specific gravity. -1.409

g) Saccharifying quality. —35.48%

h) Hardness. (kilo)

uuder 3.75	1 grains.
3.75—5.63	14 "
5.63—7.50	35 "
7.50—9.38	—
above 9.38	—

average.	max.	min.
5.90	7.39	3.33

i) Volume of 100g. 128.0c.c.

j) Weight of 1,000 grains. —23.75g.

k) Volume of 1,000 grains. 17.0c.c.

l) Phytin. — 0.44%

m) Thickness of bran layer. (μ)

average.	max.	min.
46.00	51.98	40.73

n) Absorption of water.

Time steeped.	% absorbed.
24 h.	22.26

o) Depth of embryo cavity .—

average.	max	min.
0.23	0.27	0.19

p) Chemical composition —

		unhydrous.
Water	13.29	—
D. R. sugar	1.79	2.10
Starch	71.61	83.75
Crude fat	2.39	2.78
" fibre	0.92	1.08
" protein	7.62	8.91
Ash	1.18	1.38
Phosphoric acid	0 42	0.50

Q) *Production of Aichi prefecture.*

a) Percentage of full grown grains. 66.77%

b) External appearance and luster. Greyish straw yellow colour, grains were not fat, no luster, impurities were abundant.

c) Size of grains. (m.m.)

thickness above	2 2	23.57 g	12 grains.
" "	2.0	39.58 "	20 "
" "	1 8	28.39 "	14 "
" "	1.6	6.40 "	3 "
" under	1.6	1.97 "	1 "

	average.	max.	min.
length	5.08	5.50	4.30
width	2.95	3.20	2.60

d) Percentage of Shinziromai. —30.5%

e) Depth of longitudinal furrow. (μ)

average	max.	min.
64.01	103.80	34.60

f) Specific gravity. 1.382

g) Saccharifying quality.— 28.34%

h) Hardness. (kilo)

under 3.75	5 grains.
3.75—5.63	25 〃
5.63—7.50	20 〃
7.50—9.38	—
above 9.38	—

average.	max.	min.
5.16	7.24	2.87

i) Volume of 100g.— 130.0c.c.

j) Weight of 1,000 grains. - 22.5g.

k) Volume of 1,000 grains. - 16.2c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
15.99	49.73	41.40

n) Absorption of water.

Time steeped.	% absorbed.
24 h.	25.6

o) Depth of embryo cavity :—

average.	max.	min.
0.26	0.33	0.20

p) Chemical composition :—

		unhydrous.
Water	13.91	—
D. R. sugar	1.92	2.26
Starch	70.27	82.37
Crude fat	2.34	2.71
〃 fibre	1.20	1.41
〃 protein	8 29	9.71
Ash	1.29	1 51
Phosphoric acid	0.38	0.15

R) *Production of Miye prefecture.*

a) Percentage of full grown grains. 76.5%

b) External appearance and luster. Nearly same as Q).

c) Size of grains. (m.m.)

thickness above	2.2	14.70 g.	7 grains.
〃 〃	2.0	47.49 〃	24 〃
〃 〃	1.8	34.11 〃	17 〃
〃 〃	1.6	3.30 〃	2 〃
〃 under	1.6	0.40 〃	—

	average.	max.	min.
length	5.21	5.55	5.0
width	2.98	3.15	2.7

d) Percentage of Shinziromai. — 30.9%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
60.77	77.85	25.95

f) Specific gravity.——1.394

g) Saccharifying quality. —— 34.84%

h) Hardness. (kilo)

under 3.75	1 grains.
3.75—5.63	26 〃
5.63—7.50	23 〃
7.50—9.38	—
above 9.38	—

average.	max.	min.
5.44	7.01	3.53

i) Volume of 100g.—— 125.5c.c.

j) Weight of 1,000 grains. —22.85g.

k) Volume of 1,000 grains.– 16.5c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
46.88	52 73	42.98

n) Absorption of water.

time steeped.	% absorbed.
24 h.	25.32

o) Depth of embryo cavity :—

average.	max.	min
0.25	0 31	0.18

p) Chemical composition :—

		unhydrous.
Water	13 07	—
D. R sugar	1.42	1.63
Starch	72.66	83.84
Crude fat	2.48	2,87
〃 fibre	0.85	0.98
〃 protein	7.88	9.09
Ash	1.48	1.71
Phosphoric acid	0 48	0 56

S) *Production of Okayama prefecture.*

a) Percentage of full grown grains. – 89.25%

b) Exteral appearance luster. – – Light straw yellow waxy luster, grains were fat and large.

c) Size of grains. (m.m.)

thickness above	2.2	66 47 g.	33 grains.
〃 〃	2.0	27.90 〃	14 〃
〃 〃	1.8	5 00 〃	3 〃
〃 〃	1.8	0.44 〃	—
〃 under	1.6	0.17 〃	—

	average.	max.	min.
length	5.40	5.85	4.90
width	3.01	3.15	2.55

d) Percentage of Shinziromai. -- 42.7%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
51.47	69.00	25.95

f) Specific gravity. 1.399

g) Saccharifying quality. 35.04%

h) Hardness. (kilo)

under 3.75	11 grains.
3.75—5.63	32 〃
5.63—7.50	7 〃
7.50—9.38	—
above 9.38	—

average.	max	min.
4.35	7.31	2.51

i) Volume of 100g. -- 124.5c.c.

j) Weight of 1,000 grains.- 26.52g.

k) Volume of 1,000 grains. --19.0c.c.

l) Phytin. 0.38%

m) Thickness of bran layer. (μ)

average	max.	min.
48.54	56.48	42.53

n) Absorption of water.

Time steeped.	% absorbed.
24 h.	24.02

o) Depth of embryo cavity :—

average.	max.	min.
0.25	0.31	0.18

p) Chemical composition

		unhydrous.
Water	13.04	—
D. R. sugar	1.22	1.40
Starch	73.29	84.52
Crude fat	2.16	2.49
〃 fibre	1.50	1.73
〃 protein	7.46	8.60
Ash	1.10	1.27
Phosphoric acid	0.46	0.53

T) *Production of Hiroshima prefecture.*

a) Percentage of full grown grains.——85.15%

b) External appearance and luster. ——Nearly same as S).

c) Size of grains. (m.m.)

thickness above	2.2	60.25 g.	30 grains.
" "	2.0	29.83 "	15 "
" "	1.8	9.24 "	5 "
" "	1.6	0.56 "	—
" under	1.6	0.11 "	—
	average.	max.	min.
length	5.36	5.70	4.95
width	3.07	3.25	2.90

d) Percentage of Shinziromai.——59.0 %

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
55.79	103.80	34.60

f) Specific gravity.——1.409

g) Saccharifying quality.——38.32 %

h) Hardness. (kilo)

under 3.75	8 grains.
3.75—5.63	27 "
5.63—7.50	12 "
7.50—9.38	3 "
above 9.38	—

average	max.	min.
5.17	7.88	2.81

i) Volume of 100g.——123.0c.c.

j) Weight of 1,000 grains. ——25.95g.

k) Volume of 1,000 grains. ——18.5c.c.

l) Phytin. 0.38%

m) Thickness of bran layer. (μ)

average.	max.	min.
46 41	51.08	40 40

n) Absorption of water.

time steeped.	% absorbed.
24 h.	24.46

o) Depth of embryo cavity :—

average.	max.	min.
0.26	0.33	0.12

p) Chemical composition :—

		unhydrous.
Water	13.10	—
Direct R. sugar	0.94	1.09
Starch	73.03	84.99
Crude fat	2.27	2.65
" fibre	1.10	1.28
" protein	7.46	8.68
Ash	1.12	1.31
Phosphoric acid	0.45	0.52

β) Polished rice, suitable for the Saké brewing. 20 (A–T) varieties.

A) *Production of Okayama prefecture.*

a) Percentage of full grown grains.——97.35%.

b) External appearance and luster.——White glassy luster, grains were fat and large.

c) Size of grains. (m.m.)

thickness above	2.2	69.9 g.	35 grains.
〃 〃	2 0	27.3 〃	14 〃
〃 〃	1.8	2.45 〃	1 〃
〃 〃	1.6	0.15 〃	—
〃 under	1.6	0.10 〃	—
	average.	max.	min.
length	5.32	5.75	4.95
width	3.05	3.25	2.80

d) Percentage of Shinziromai.——84.42 %

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
34.82	69.20	8.65

f) Specific gravity.——1.429

g) Saccharifying quality.——22.71 %

h) Hardness. (kilo)

under 3 75	46 grains.
3.75—5.63	4 〃
5.63—7.50	—
7.50—9.38	—
above 9.38	—

average	max.	min.
2.99	4 28	1.97

i) Volume of 100g.——120.0c.c.

j) Weight of 1,000 grains.——25.45g.

k) Volume of 1,000 grains. 18.8c.c.

l) Phytin. 0.02%

n) Absorption of water.

time steeped.	% absorbed.
24 h.	19.9

p) Chemical composition :—

		unhydrous.
Water	13.27	—
Direct R. sugar	0.46	0.54
Starch	78.28	90.52
Crude fat	0.29	0.34
〃 fibre	0.45	0.51
〃 prote'n	6.69	7.74
Ash	0.30	0.35
Phosphoric acid	0.18	0.21

B) *Production of Okayama prefecture.*

a) Percentage of full grown grains.——96.73 %

b) External appearance and luster.——Same as A).

c) Size of grains. (m.m.)

thickness above	2.2	48.1 g.	24 grains.
〃 〃	2.0	42.15 〃	21 〃
〃 〃	1.8	9.25 〃	5 〃
〃 〃	1.6	0.42 〃	—
〃 under	1.6	0 05 〃	—

	average.	max.	min.
length	5.21	5.65	4.70
width	2.95	3.15	2.55

d) Percentage of Shinziromai.——63.28 %

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
27.64	51.90	5.19

f) Specific gravity. 1.449

g) Saccharifying quality. - -24.64%

h) Hardness. (kilo)

under 3.75	43 grains.
3.75—5.63	7 〃
5.63—7.50	—
7.50—9.38	—
above 9.38	—

average.	max.	min.
2.91	4.65	1.97

i) Volume of 100g.——119.0c.c.

j) Weight of 1,000 grains.——23.75g.

k) Volume of 1,000 grains. —16.6c.c.

l) Phytin. 0.06%

n) Absorption of water.

time steeped.	% absorbed
2 h.	20.08

p) Chemical composition :—

		unhydrous.
Water	13.22	—
Direct. R. sugar	0.54	0.62
Starch	78.22	90.30
Crude fat	0.37	0.43
〃 fibre	0.62	0.72
〃 protein	6.53	7.54
Ash	0.35	0.40
Phosphoric acid	0.18	0.21

C) *Production of Niigata prefecture.*

a) Percentage of full grown grains.——94.58 %

b) External appearance and luster.——Slightly brownish glassy luster, grains were not fat and of middle size.

c) Size of grains. (m.m.)

thickness above	2.2	27 8 g.	14 grains.
〃 〃	2.0	57.9 〃	29 〃
〃 〃	1.8	13.22 〃	6 〃
〃 〃	1.6	0.95 〃	1 〃
〃 under	1.6	0.11 〃	—
	average.	max.	min.
length	5.12	5.60	1.55
width	2.93	3.10	2 40

d) Percentage of Shinziromai.——16.4 %

e) Depth of longitudinal furrow. (μ)

average	max	min.
34.38	51.90	17.30

f) Specific gravity.——1.429

g) Saccharifying quality.——29.48 %

h) Hardness. (kilo)

under 3.75	50 grains.
3.75—5.63	—
5.63—7.50	—
7.50—9.38	—
above 9.38	—

average.	max	min.
2.56	3.38	1.97

i) Volume of 100g.——120.5c.c.

j) Weight of 1,000 grains.——21.8g.

k) Volume of 1,000 grains.——15.3c.c.

n) Absorption of water.

time steeped.	% absorbed.
2 h.	16.66

p) Chemical composition :—

		unhydrous.
Water	14.05	—
D. R. sugar	0.50	0.58
Starch	77.24	89.90
Crude fat	0.29	0.33
〃 fibre	0.31	0.36
〃 protein	7.29	8.48
Ash	0.29	0.34
Phosphoric acid	0.18	0.20

D) *Production of Hyogo prefecture.*

a) Percentage of full grown grains.——93.9%.

b) External appearance and luster.——nearly same as A).

c) Size of grains. (m.m)

thickness above	2 2	14 22 g.	7 grains.
〃 〃	2 0	51.51 〃	26 〃
〃 〃	1.8	33.45 〃	17 〃
〃 〃	1 6	0 82 〃	—
〃 under	1 6	—	—
	average	max	min.
length	5 23	5 65	4 80
width	3 01	3.25	2.70

d) Percentage of Shinziromai.——85.0 %

e) Depth of longitudinal furrow. (μ)

average	max	min
46 49	69 20	17 30

f) Specific gravity.——1.449

g) Saccharifying quality.——19.22 %

h) Hardness. (kilo)

under 3 75		42 grains.
3 75—5 63		8 〃
5 63—7 50		—
7 50—9 38		—
above 9 38		—
average	max	min
3 18	4 71	2 06

i) Volume of 100g.——116.0c.c.

j) Weight of 1,000 grains.——22.39g.
24.29g. (Shinziromai)

k) Volume of 1,000 grains. 15.4c.c.
16.9c.c. (Shinziromai)

l) Phytin. 0.03%

n) Absorption of water.

time steeped	% absorbed.
2 h	20 86

p) Chemical composition —

		unhydrous
Water	13 10	—
D R sugar	0 39	0 46
Starch	77 48	90.40
Crude fat	0 16	0.19
〃 fibre	0 77	0 90
〃 protein	6 61	7.71
Ash	0 30	0.34
Phosphoric acid	0.17	0.19

E) *Production of Hyogo prefecture.*

a) Percentage of full grown grains.——94.16%

b) External appearance and luster.——Same as before.

c) Size of grains. (m.m.)

thickness above	2.2	23.45 g	12 grains.
〃 〃	2.0	47.55 〃	24 〃
〃 〃	1 8	28.18 〃	14 〃
〃 〃	1.6	0.72 〃	—
〃 under	1.6	—	—

	average.	max.	min.
length	5.15	5.55	4.75
width	2.98	3.15	2.70

d) Percentage of Shinziromai.——74.48%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
41.95	77 85	17.30

f) Specific gravity.——1.449%.

g) Saccharifying quality.——21.68%

h) Hardness. (kilo)

under 3.75	40 grains.
3.75—5.63	10 〃
5.63—7 50	—
7 50—9.38	—
above 9.38	—

average.	max.	min.
3.24	4.69	2 03

i) Volume of 100g.——113.5c.c.

j) Weight of 1,000 grains.——22.68g.

k) Volume of 1,000 grains. 15.9c.c.

n) Absorption of water.

time steeped	% absorbed.
2 h.	20.3

p) Chemical composition :—

		unhydrous.
Water	13.06	—
D. R sugar.	0.40	0.46
Starch	78.92	90.92
Crude fat	0.16	0.18
〃 fibre	0.35	0.40
〃 protein	6.61	7.62
Ash	0.27	0.31
Phosphoric acid	0 17	0.20

F) *Production of Hyogo prefecture.*

a) Percentage of full grown grains.——94.62 %

b) External appearance and luster.——Nearly same as before.

c) Size of grains. (m.m.)

thickness above	2.2	35.45 g.	18 grains.
〃 〃	2.0	44.4 〃	22 〃
〃 〃	1.8	19.6 〃	10 〃
〃 〃	1.6	0.55 〃	—
〃 under	1.6	—	—

	average.	max	min.
length	5.16	5.55	4.70
width	2 99	3.25	2.70

d) Percentage of Shinziromai.——54.56 %

e) Depth of longitudinal furrow. (μ)

average.	max	min.
48 22	77.85	25 95

f) Specific gravity.——1.439

g) Saccharifying quality.——17.27%

h) Hardness. (kilo)

under 3.75	43 grains.
3.75—5 63	7 〃
5.63—7.50	—
7 50—9.38	—
above 9.38	—

average.	max	min.
3.15	4.69	2 16

i) Volume of 100g.——112.0c.c.

j) Weight of 1,000 grains.——23.0g.

k) Volume of 1,000 grains.——16.25c.c.

n) Absorption of water.

time steeped	% absorbed
2 h.	19 6

p) Chemical composition :—

		unhydrous.
Water	13.48	—
D. R. sugar	0.41	0.47
Starch	78.62	91.07
Crude fat	0.20	0.23
〃 fibre	0.39	0.45
〃 protein	6.44	7.46
Ash	0.27	0.32
Phosphoric acid	0.16	0.19

G) *Production of Fukuoka prefecture.*

a) Percentage of full grown grains.——79.33%

b) External appearance and luster.——Slightly brown white colour, destitute of luster, grains were not fat and of middle size.

c) Size of grains. (m.m.)

thickness above	2.2	12.45 g.	6 grains.
〃 〃	2.0	41.49 〃	21 〃
〃 〃	1.8	40.45 〃	20 〃
〃 〃	1.6	4.20 〃	2 〃
〃 under	1.6	1.36 〃	1 〃
	average	max.	min.
length	5.01	5.40	4.55
width	2.95	3.15	2.70

d) Percentage of Shinziromai.——24.44%

e) Depth of longitudinal furrow. (μ)

average.	max.	min
46.71	69.20	17.30

f) Specific gravity.——1.439

g) Saccharifying quality.——19.88%

h) Hardness. (kilo)

under 3.75	35 grains.
3.75—5.63	15 〃
5.63—7.50	—
7.50—9.38	—
above 9.38	—

average.	max.	min.
3.48	5.06	2.29

i) Volume of 100g.——120.5c.c.

j) Weight of 1,000 grains.——21.19g.

k) Volume of 1,000 grains.——15.0c.c.

l) Phytin. 0.07%

n) Absorption of water.

time steeped.	% absorbed.
2 h.	19.52

p) Chemical composition.—

		unhydrous.
Water	12.97	—
D. R. sugar	0.30	0.35
Starch	77.27	89.33
Crude fat	0.25	0.29
〃 fibre	0.54	0.62
〃 protein	7.62	8.82
Ash	0.52	0.60
Phosphoric acid	0.27	0.31

H) *Production of Kumamoto prefecture.*

a) Percentage of full grown grains.——82.57%

b) External appearance and luster.—— Nearly same as G).

c) Size of grains. (m.m.)

thickness	above	2.2	37.92 g. 19 grains.
〃	〃	2.0	52.00 〃 26 〃
〃	〃	1.8	6.33 〃 3 〃
〃	〃	1.6	3.40 〃 2 〃
〃	under	1.6	0.34 〃 —

	average.	max.	min.
length	5.07	5.25	4.45
width	2.99	3.15	2.60

d) Percentage of Shinziromai.——34.8%

e) Depth of longitudinal furrow. (μ)

average	max.	min.
34.17	51.90	8 65

f) Specific gravity.——1.439.

g) Saccharifying quality. 29.73%

h) Hardness. (kilo)

under 3 75	32 grains.
3.75—5 63	18 〃
5.63—7 50	—
7 50—9 38	—
above 9 38	—

average.	max	min
3.52	5 25	2.12

i) Volume of 100g. — 121.0c.c.

j) Weight of 1,000 grains.——20.30g.

k) Volume of 1,000 grains. — 14.9c.c.

l) Phytin. 0.04%

n) Absorption of water.

time steeped.	% absorbed.
2 h	20.40

p) Chemical composition.——

		unhydrous.
Water	12.82	—
D. R sugar	0.25	0.29
Starch	78.92	90.73
Crude fat	0.15	0.17
〃 fibre	0.22	0.25
〃 protein	7.04	8.09
Ash	0.42	0.48
Phosphoric acid	0.17	0.20

I) *Production of Saga prefecture.*

a) Percentage of full grown grains.——87.01%

b) External appearance and luster.- - —Nearly same as A).

c) Size of grains. (m.m.)

thickness above	2.2	43.55 g.	22 grains.
" "	2.0	44.05 "	22 "
" "	1.8	11.43 "	6 "
" "	1.6	0.52 "	—
" under	1.6	0.35 "	—

	average.	max.	min.
length	4.96	5.25	4.60
width	3.01	3.15	2.70

d) Percentage of Shinziromai.——35.5%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
30.49	51.90	17.30

f) Specific gravity.- — 1.449

g) Saccharifying quality. - 19.71%

h) Hardness. (kilo)

under 3.75	32 grains.
3.75—5.63	18 "
5.63—7.50	—
7.50—9.38	—
above 9.38	—

average.	max.	min.
3.51	50.1	19.34

i) Volume of 100g.——119.0c.c.

j) Weight of 1,000 grains.——22.73g.

k) Volume of 1,000 grains. 16.0c.c.

l) Phytin.——0.02%

n) Absorption of water.

time steeped.	% absorbed.
2 h.	19.34

p) Chemical composition :—

		unhydrous
Water	12.58	—
D. R. sugar	0.46	0.53
Starch	78.96	90.93
Crude fat	0.13	0.15
" fibre	0.22	0.25
" protein	7.29	8.34
Ash	0.38	0.42
Phosphoric acid	0.24	0.28

J) *Production of Kagawa prefecture.*

a) Percentage of full grown grains.——90.87%

b) External appearance and luster.——Greyish white colour, destitute of luster, grains were fat and of middle size.

c) Size of grains. (m.m.)

thickness	above	2.2	32.38 g.	16 grains.
〃	〃	2 0	50.97 〃	26 〃
〃	〃	1.8	16.40 〃	8 〃
〃	〃	1.6	0.24 〃	—
〃	under	1.6	—	

	average	max	min.
length	5.04	5 25	4.7
width	3.01	3 20	2 7

d) Percentage of Shinziromai. 66.88%

e) Depth of longitudinal furrow. (μ)

average	max.	min.
43.47	77.85	17 30

f) Specific gravity.——1.443.

g) Saccharifying quality.——17.67%

h) Hardness. (kilo)

under 3.75	20 grains
3 75—5.63	30 〃
5 63—7.50	—
7 50—9.38	—
above 9 38	—

average.	max	min
4 17	5.59	2 51

i) Volume of 100g.——119.0c.c.

j) Weight of 1,000 grains. 22.34g.

k) Volume of 1,000 grains. 15.4c.c.

l) Phytin. 0.09%

n) Absorption of water.

time steeped	% absorbed
2 h.	21.26

p) Chemical composition.—

		unhydrous.
Water	13 40	—
D R sugar	0.51	0.59
Starch	77.23	90.58
Crude fat	0.36	0.42
〃 fibre	0 28	0.32
〃 protein	6.35	7.45
Ash	0.54	0.63
Phosphoric acid	0.21	0.25

L) *Production of Yehime prefecture.*

a) Percentage of full grown grains.——92.93%

b) External appearance and luster.——White lustrous, of middle size.

c) Size of grains. (m.m.)

thickness above	2.2	34.39 g.	17 grains.
" "	2.0	44.88 "	23 "
" "	1.8	20.18 "	10 "
" "	1.6	0.38 "	—
" under	1.6	0.02 "	—

	average.	max.	min.
length	5.21	5.65	4.50
width	3.11	3.20	2.60

d) Percentage of Shinziromai.——69.68%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
36.76	77.85	8.65

f) Specific gravity. ——1.439

g) Saccharifying quality. — 17.94%

h) Hardness. (kilo)

under 3.75	18 grains.
3.75—5.63	24 "
5.63—7.50	8 "
7.50—9.38	—
above 9.38	—

average.	max.	min.
4.35	6.75	1.99

i) Volume of 100g.—— 123.0c.c.

j) Weight of 1,000 grains.——23.44g.

k) Volume of 1,000 grains. —16.3c.c.

l) Phytin. 0.01%

n) Absorption of water.

time steeped.	% absorbed.
2 h.	20.44

p) Chemical composition :—

		unhydrous
Water	13.27	—
D. R. sugar	0.24	0.28
Starch	77.47	90.17
Crude fat	0.22	0.26
" fibre	0.36	0.41
" protein	7.20	8.38
Ash	0.42	0.49
Phosphoric acid	0.16	0.19

M) *Production of Fukushima prefecture.*

a) Percentage of full grown grains.——92.5%

b) External appearance and luster.— - Nearly same as J).

c) Size of grains. (m.m.)

thickness	above	2.2	34.77 g.	17 grains
〃	〃	2.0	39.60 〃	20 〃
〃	〃	1.8	23 54 〃	12 〃
〃	〃	1.6	1.48 〃	1 〃
〃	under	1.6	0.35 〃	—
		average.	max.	min.
	length	4 85	5.35	4.25
	width	2.97	3.15	2.97 (?)

d) Percentage of Shinziromai. ——43.08%

e) Depth of longitudinal furrow. (μ)

average.	max.	mim.
41.52	86.50	17.30

f) Specific gravity. — 1.443

g) Saccharifying quality.——32.75%

h) Hardness. (kilo)

under 3.75	12 grains.
3.75—5.63	36 〃
5.63—7.50	2 〃
7.50—9.38	—
above 9.38	—

average.	max.	min.
4.17	6.19	2.18

i) Volume of 100g.——117.0c.c.

j) Weight of 1,000 grains.——21.62g.
23.55g. (Shinziromai)

k) Volume of 1,000 grains. 15.2c.c.
16.4c.c. (Shinziromai)

l) Phytin. — 0.03%

n) Absorption of water.

time steeped.	% absorbed.
2 h.	18.4

p) Chemical composition.—

		unhydrous.
Water	14.04	—
D. R. sugar	0.34	0.40
Starch	77.53	90.60
Crude fat	0.36	0.42
〃 fibre	0.20	0.23
〃 protein	6.78	7.92
Ash	0.37	0.43
Phosphoric acid	0.18	0.22

N) *Production of Fukushima prefecture.*

a) Percentage of full grown grains. 84.11%

b) External appearance and luster.——Nearly same as M).

c) Size of grains. (m.m.)

thickness	above	2.2	38.04 g.	19 grains.
〃	〃	2.0	25.10 〃	12 〃
〃	〃	1.8	31.58 〃	16 〃
〃	〃	1.6	3.86 〃	2 〃
〃	under	1.6	1.32 〃	1 〃

	average.	max.	min.
length	4.92	5.25	4.30
width	2.94	3.35	2.60

d) Percentage of Shinziromai.——39.16%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
43.47	77.85	17.30

f) Specific gravity.——1.439

g) Saccharifying quality.——30.66%

h) Hardness. (kilo)

under 3.75	22 grains.
3.75—5.63	26 〃
5.63—7.50	2 〃
7.50—9.38	—
above 9.38	—

average.	max.	min.
3.83	6.00	2.03

i) Volume of 100g. -- 115.0c.c.

j) Weight of 1,000 grains.——21.7g.

k) Volume of 1,000 grains. 15.2c.c.

n) Absorption of water.

time steeped.	% absorbed.
2 h.	18.72

p) Chemical composition.—

		unhydrous.
Water	14.26	—
D. R. sugar	0.23	0.27
Starch	77.41	90.73
Crude fat	0.34	0.39
〃 fibre	0.35	0.41
〃 protein	6.69	7.85
Ash	0.30	0.35
Phosphoric acid	0.18	0.21

O) *Production of Miyagi prefecture.*

a) Percentage of full grown grains.——88.48%

b) External appearance and luster.——Nearly same as before.

c) Size of grains. (m.m.)

thickness above	2.2	3.50 g.	2 grains
〃 〃	2.0	15.94 〃	8 〃
〃 〃	1.8	74 62 〃	37 〃
〃 〃	1.6	5.19 〃	3 〃
under	1.6	0.82 〃	—

	average.	max.	min.
length	4.81	5.2	4 25
width	2.78	3.0	2.55

d) Percentage of Shinziromai.——12.44%

e) Depth of longitudinal furrow. (μ)

average	max.	min.
40 87	69 20	17 80

f) Specific gravity.——1.439

g) Saccharifying quality. -26.83%

h) Hardness. (kilo)

under 3 75	25 grains.
3 75—5.63	24 〃
5 63—7.50	1 〃
7.50—9 38	—
above 9 38	—

average	max.	min.
3 73	6 45	2 44

i) Volume of 100g.---119.0c.c.

j) Weight of 1,000 grains.——18.74g.

k) Volume of 1,000 grains. 13.0c.c.

n) Absorption of water.

time steeped.	% absorbed
2 h	17.34

p) Chemical composition —

		unhydrous
Water	13.58	—
D R sugar	0.32	0 36
Starch	78.70	90.26
Crude fat	0.36	0.41
〃 fibre	0 50	0.57
〃 protein	7.04	8 07
Ash	0.29	0 32
Phosphoric acid	0.17	0.20

P) *Production of Niigata prefecture.*

a) Percentage of full grown grains. —90.56%

b) External appearance and luster.——Slightly brownish white colour, destitute of luster, grains were of middle size and not fat.

c) Size of grains. (m.m)

thickness above		2 2	22.80 g.	11 grains.
〃	〃	2 0	45.28 〃	23 〃
〃	〃	1.8	28.75 〃	14 〃
〃	〃	1.6	1.62 〃	1 〃
〃	under	1 6	1.50 〃	1 〃
		average	max	min.
	length	5 10	5 40	4.80
	width	2 88	3.10	2 60

d) Percentage of Shinziromai. ——14.2%

e) Depth of longitudinal furrow. (μ)

average	max	min.
37 84	51 90	17 50

f) Specific gravity.——1.449

g) Saccharifying quality. ——32.85%

h) Hardness. (kilo)

under 3.75		4 grains
3.75—5.63		26 〃
5 63—7 50		20 〃
7.50—9.38		—
above 9.38		—
average	max	min.
5 19	6.92	2.78

i) Volume of 100g.——121.5c.c.

j) Weight of 1,000 grains.——21.73g.

k) Volume of 1,000 grains. ——15.8c.c.

l) Phytin. - 0.08%

n) Absorption of water.

time steeped.	% absorbed.
2 h.	19 4

p) Chemical composition :—

		unhydrous.
Water	13 35	—
D. R. sugar	0.32	0.37
Starch	77.04	89.56
Crude fat	0.36	0.42
〃 fibre	0.51	0.59
〃 protein	7.46	8.66
Ash	0.33	0.38
Phosphoric acid	0.18	0.21

Q) *Production of Aichi prefecture.*

a) Percentage of full grown grains.——81.08%

b) External appearance and luster.——Nearly same as before.

c) Size of grains. (m.m.)

thickness above	2 2	30.05 g	15 grains
〃 〃	2.0	36.00 〃	18 〃
〃 〃	1.8	27.88 〃	14 〃
〃 〃	1.6	3.93 〃	2 〃
〃 under	1.6	2 10 〃	1 〃

	average.	max.	min.
length	4.97	5 30	4 55
width	2 93	3.10	2 65

d) Percentage of Shinairomai.——57.14%

e) Depth of longitudinal furrow. (μ)

average	max.	min
36 76	69.20	17 30

f) Specific gravity.—— 1.439

g) Saccharifying quality.——18.85%

h) Hardness. (kilo)

	grains
under 3.75	16 〃
3 75—5 63	31 〃
5 63—7 50	3 〃
7.50—9.38	—
above 9 38	—

average	max	min
4 15	6 28	2 03

i) Volume of 100g. - 126.0c.c.

j) Weight of 1,000 grains.——20.85g.

k) Volume of 1,000 grains. 14.60c.c.

n) Absorption of water.

time steeped	% absorbed
2 h	19.96

p) Chemical composition :—

		unhydrous.
Water	13 34	—
D R sugar	0.33	0 38
Starch	77.54	90.05
Crude fat	0.38	0.44
〃 fibre	0.63	0.73
〃 protein	6 78	7.88
Ash	0.45	0.53
Phosphoric acid	0 21	0.25

R) *Production of Miye prefecture.*

a) Percentage of full grown grains.——67.31%

b) External appearance and luster.——White glassy luster, grains were not fat and of middle size.

c) Size of grains. (m.m.)

thickness above	2.2	6 89 g.	3 grains.
〃 〃	2 0	33 94 〃	17 〃
〃 〃	1.8	55.21 〃	28 〃
〃 〃	1.6	3.51 〃	2 〃
〃 under	1.6	0.35 〃	—

	average.	max	min.
length	5 00	5 40	1 80
width	2.90	3.00	2 60

d) Percentage of Shinziromai.——48.0%

e) Depth of longitudinal furrow. (μ)

average.	max	min.
39 79	77.85	25.95

f) Specific gravity. -- —1.439

g) Saccharifying quality.——24.71%

h) Hardness. (kilo)

under 3.75	10 grains
3.75—5.63	32 〃
5.63—7.50	8 〃
7.50—9.38	—
above 9.38	--

average.	max.	min
4.66	6 54	2.91

i) Volume of 100g. —122.0c.c.

j) Weight of 1,000 grains.— —20.85g.

k) Volume of 1,000 grains. 14.6c c.

n) Absorption of water.

time steeped.	% absorbed.
2 h.	20.30

p) Chemical composition :—

		unhydrous.
Water	12.99	—
D. R. sugar.	0.46	0.53
Starch	78.49	90.43
Crude fat	0.25	0.29
〃 fibre	0.52	0.59
〃 protein	6.61	7.61
Ash	0.47	0.54
Phosphoric acid	0.18	0.21

S) *Production of Okayama prefecture.*

a) Percentage of full grown grains.——96.8%

b) External appearance and luster.——Same as A)

c) Size of grains. (m.m.)

thickness above	2.2	11.39 g.	6 grains.
// //	2.0	42.76 //	21 //
// //	1.8	43.95 //	22 //
// //	1.6	1.60 //	1 //
// under	1.6	0.28 //	—

	average.	max.	min.
length	5.31	5.75	4.90
width	2.98	3.20	2.75

d) Percentage of Shinziromai.——55.3%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
11.63	34.60	0

f) Specific gravity.— 1.439

g) Saccharifying quality.——29.53%

h) Hardness. (kilo)

under 3.75	31 grains.
3.75—5.63	19 //
5.63—7.50	— //
7.50—9 38	— //
above 9.38	—

average.	max.	min.
3.89	5.48	2.06

i) Volume of 100g.——120.0c.c.

j) Weight of 1,000 grains. — 23.01g.

k) Volume of 1,000 grains. ——16.0c.c.

l) Phytin.— 0.01%

n) Absorption of water.

time steeped.	% absorbed.
2 h.	21.2

p) Chemical composition :—

		unhydrous.
Water	12.75	—
D. R. sugar	0.45	0.52
Starch	78.58	90.93
Crude fat	0.21	0.24
// fibre	0.52	0.60
// protein	6.35	7.35
Ash	0 32	0.36
Phosphoric acid	0.15	0.18

T) *Production of Hiroshima prefecture.*

a) Percentage of full grown grains.——87.91%

b) External appearance and luster.——Nearly same as before.

c) Size of grains. (m.m.)

thickness above	2.2	14.11 g.	7 grains.
〃 〃	2 0	37.05 〃	19 〃
〃 〃	1.8	41.37 〃	21 〃
〃 〃	1.6	4.99 〃	2 〃
〃 under	1.6	2.40 〃	1 〃

	average.	max.	min.
length	4.97	5.40	4.60
width	2.86	3.00	2.65

d) Percentage of Shinziromai.——56.88%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
21.02	43.25	5.19

f) Specific gravity. - 1.439

g) Saccharifying quality.——32.50%

h) Hardness. (kilo)

under 3.75	40 grains.
3.75—5.63	10 〃
5.63—7.50	—
7.50—9.38	—
above 9.38	—

average.	max.	min.
3 29	5 14	1.97

i) Volume of 100g.— —118.0c.c.

j) Weight of 1,000 grains.——21.18g.

k) Volume of 1,000 grains.— -14.7c.c.

l) Phytin.- 0.01

n) Absorption of water.

time steeped.	% absorbed.
2 h.	20.26

p) Chemical composition :—

		unhydrous.
Water	13.04	—
D. R. sugar	0.47	0.54
Starch	78.86	90 87
Crude fat	0.20	0.23
〃 fibre	0.31	0.35
〃 protein	6 61	7.61
Ash	0.34	0.39
Phosphoric acid	0.15	0.17

TABLE I. 1917 Husked rice

(Suitable for the Saké brewing.)

	% of full grown grain.	% of Shiniromai	Depth of longitudinal furrow (μ)	Specific gravity.	Saccharifying quality. (%)	Hardness. (kilo)	Absorption of water. (%)	Volume of 100g. (c.c)	Weight of 1,000 grains (g.)	Volume of 1,000 grains.(c.c)	Thickness of bran layer.(μ)	Depth of embryo cavity	Water	D. R. sugar	Starch	Crude fat	Crude fibre	Crude protein	Ash	P_2O_5
A	90.33	95.64	41.52	1.40	27.30	4.54	22.30	124 0	28.23	20.25	50 27	0.24	12.88	1.11	84.42	2.55	1.90	9.19	1.37	0.51
B	90.48	58.60	31.57	1.40	30.04	5.32	23 22	122 0	26.45	18.90	45.60	0.25	13.07	1.08	85.23	2.23	1.73	8 28	1.44	0.58
C	95.00	12 30	41.74	1.40	30.15	4 10	19.10	131.0	24.22	16.60	45 77	0 23	14 24	1.30	84.35	2.64	1.15	9.20	1.38	0.51
D	89.86	77.00	67.34	1.41	30.28	4.69	21.96	122 0	25.78	18.40	44.65	0 28	13.14	0.79	85.72	2:41	1.32	8.40	1.36	0.23
E	88.83	69.84	57.18	1.41	32.06	4.48	21.60	126.5	25.35	18.10	44.53	0 28	13.59	1.40	84.30	2.44	1.27	9.25	1.35	0.48
F	93.40	64.00	58.60	1.41	26.32	4.24	20.80	123.0	25.12	18.00	43.28	0.28	13.34	1.31	84.79	2.42	1.16	9.17	1.03	0.60
G	86.38	20.60	58.39	1.39	31.26	5.71	24.46	129 0	23.05	16.55	44.06	0.26	12.46	1.15	84.18	2.80	1.58	8.83	1.46	0.69
H	89.23	32.20	55.14	1.40	34.18	5.35	23 48	121.0	22.37	16.00	42.39	0.28	12 53	1.23	83.91	2.86	1.41	9.21	1.38	0.57
I	89.63	31.50	61.63	1.41	32.07	5.66	24.08	125.0	22.70	16.90	42 89	0.27	12.82	1.37	83.79	2.79	1.38	9 23	1.46	0.61
J	85.05	40.76	56.23	1.41	34.36	5.19	25 34	126 0	24.23	17.30	45.88	0 27	12.72	1 06	84.59	2.80	1.42	8.73	1.42	0.62
K	87.96	52.71	51.47	1.40	37.43	5.26	21.36	124.0	25.77	18.30	44.79	0.27	13.46	0 96	84.59	2.68	1.20	9.22	1.34	0 59
L	89.48	63.68	50.60	1.41	36.17	5.79	23.92	124.0	25.50	18.20	44.46	0.25	12.51	1 25	83.91	2.94	1.69	8.82	1.38	0.53
M	89.40	19.04	60.55	1.42	37.52	5.11	21.04	130.0	24.10	17.10	45.61	0.26	13.74	0.85	85.25	2.45	1.26	8.70	1.49	0.57
N	74.05	16.72	49.95	1.38	34.88	5.18	22.52	132.0	23.62	17.10	46.20	0.26	14.54	1.62	84.77	2.53	1.09	8.49	1.50	0.55
O	86.20	9 50	55.15	1.39	28.01	4.80	20.76	130.5	20.47	14 70	42.74	0.26	14.07	1.42	84.78	2.59	0.91	8.88	1.44	0.64
P	92 42	10 50	51.04	1.41	35.48	5.90	22.26	128.0	23.75	17.00	45.00	0.23	13.29	2.10	83.75	2.78	1.08	8.91	1.38	0.50
Q	66.77	30.50	64.01	1.38	28.34	5.16	25.60	130.0	22.50	16.20	45.99	0.26	13.91	2.26	83.37	2.74	1.41	9.71	1.51	0.45
R	76.50	30.90	60.77	1.39	34.84	5.44	25.32	125.5	22 85	16.50	46.88	0.25	13.07	1.63	83.84	2.87	0.98	9.09	1.71	0.56
S	89.25	42.70	51.47	1.40	35.04	4.35	24.02	124.5	26.51	19.00	48.54	0.25	13.04	2.40	84.52	2.49	1.73	8.60	1.27	0.53
T	85.15	58 00	55.79	1.41	38.32	5.17	24.46	123.0	25.95	18.50	46.41	0.26	13.10	1.09	84.99	2.65	1.28	8.68	1.81	0.52

TABLE IV. 1917 Polished rice.

(Suitable f the Saké brewing.

	% of full grown grain.	% of Shinziromai	Depth of longitudinal furrow(μ)	Specific gravity	Saccharifying quality. (%)	Hardness. (kilo)	Absorption of water (%)	Volume of 100g. (c.c.)	Weight of 1,000grains.(g.)	Volume of 1,000 grains. (c.c.)	Water	D. R. sugar	Starch	Crude fat	Crude fibre	Crude protein	Ash	P_2O_5
A	97.35	86.41	34.82	1.43	22.71	2 99	19.90	120.0	25.45	18.80	13.27	0.54	90.52	0.34	0.51	7.74	0.35	0.21
B	96.73	63.28	27.64	1.45	24.64	2.91	20.08	119.0	27.75	16.60	13 22	0.62	90.20	0.43	0.72	7.54	0.40	0.21
C	94.58	16.40	34.38	1.43	29.48	2.56	16.66	120.5	21.80	15 30	14.05	0.58	89.90	0.33	0.36	8.48	0.34	0.20
D	93.90	85.00	46.49	1.45	19.22	3.18	20.86	116.0	22.39	15.40	13 10	0 46	90.40	0.19	0.90	7.71	0.34	0.19
E	94.16	74.48	41.95	1.45	21.68	3.24	20.30	113.5	22.68	15.90	13.06	0.46	90.92	0.18	0.40	7.62	0.31	0.20
F	94.62	54.56	48.22	1.44	17.27	3.15	19.60	112.5	23.00	16.25	13 48	0 47	91.07	0.23	0.45	7 46	0.32	0.19
G	79.33	24 44	46.71	1.44	19.88	3.48	19.52	120.5	21.19	15.00	12.97	0.35	89.33	0.29	0 62	8.82	0·60	0.31
H	82.57	24.80	34.17	1.44	29.73	3.52	20.40	121.0	20.30	14.90	12.82	0.29	90.73	0.17	0.25	8.09	0.48	0.20
I	87.01	35.50	30.49	1.45	19.71	3.51	19.34	119.0	22.73	16.00	12 58	0.53	90.93	0.15	0 25	8.34	0.42	0.28
J	90.87	66.88	43.47	1.44	17.67	3.42	21 26	119.0	22.34	15.40	13 40	0.59	90.58	0.42	0.32	7.45	0.63	0 25
L	92.93	69.68	36.76	1.44	17.94	4.35	20.44	123.0	23.44	16.30	13.27	0.28	90.17	0.26	0.41	8 38	0.49	0.19
M	92.50	43.08	41.52	1.44	32.75	4.17	18.40	117.0	21.62	15 20	14 04	0.40	90.60	0.42	0.23	7.92	0.43	0.22
N	84.11	39.16	43.47	1.44	30.66	3 83	18.72	115.0	21.70	15.20	14.26	0.27	90.63	0.39	0.41	7 85	0.35	0.21
O	88.48	21.44	40.87	1.44	26.83	3.73	17.34	119.0	18.74	13.00	13.58	0 36	90.26	0 41	0.57	8.07	0.32	0.20
P	90.56	14.20	37.84	1.45	32.85	5.19	19.40	121.5	21.73	15.80	13.35	0.37	89.56	0.42	0.59	8.66	0.38	0.21
Q	81.08	57.14	36.76	1.44	18.85	4.15	19.96	126.0	20.85	14.60	13.34	0.38	90.05	0.44	0.73	7.88	0.53	0.25
R	67.31	58.00	39.79	1.44	24.71	4 66	20.30	122.0	20.85	14.60	12.99	0.53	90.43	0.29	0.59	7.61	0.54	0.21
S	96.80	55.30	11.63	1.44	29.53	3.39	21.20	120.0	23.01	16.00	12.75	0.62	90.93	0.24	0.60	7.35	0.36	0.18
T	87.91	56.88	21.02	1.44	32.50	3.29	20.26	118.0	21.18	14.70	13.04	0.54	90.87	0.23	0.35	7.61	0 39	0.17

TABLE V. 1917 Husked rice.

	General average (20 var.)	Average of those under general average.	Average of those above general average.
Percentage of full grown grains. ...	86.77	90.41(13)	80.02(7)
Percentage of shinziromai.	42.03	23.25(11)	65.05(9)
Depth of longitudinal furrow. (μ) ...	54.01	46.17(8)	59.24(12)
Specific gravity	1.40	1.39(10)	1.41(11)
Saccharifying quality. (%)	32.70	29.58(10)	35.82(10)
Hardness. (kilo)	5.05	4.46(7)	5.51(13)
Absorption of water. (%).....	22.88	21.37(10)	24.39(10)
Volume of 100g. (c.c.).....	126.0	123.7(12)	129.7(8)
Weight of 1,000 grains. (g.)	24.47	23.20(11)	26.07(9)
Volume of 1,000 grains. (c.c.)	17.48	16.54(11)	18.23(9)
Thickness of bran layer. (μ)	45.40	43.88(10)	46.72(10)
Depth of embryo cavity.	0.26	0.25(10)	0.27(10)
Water	13.28	12.85(11)	13.79(9)
D. R. sugar.....	1.32	1.10(12)	1.65(8)
Starch	84.66	84.04(13)	85.04(7)
Crude fat	2.76	2.52(13)	2.83(7)
Crude fibre	1.35	1.15(11)	1.58(9)
Crude protein	8.92	8.66(11)	9.25(9)
Ash	1.40	1 32(11)	1.49(9)
Phosphoric acid	0.52	0.45(6)	6.58(14)

TABLE VI. 1917 Polished rice.

	General average (20 var.)	Average of those under general average.	Average of those above general average.
% of full grown grains.	87.25	93.69 13)	76.24(7)
% of Shinziromai.	49.68	31.01(9)	65.97(11)
Depth of longitudinal furrow. (μ)...	37.56	29.75(9)	43.96(11)
Specific gravity.	1.44	1.44(12)	1.45(8)
Sacch. quality. (%)	24.17	18.98(10)	29.37(10)
Hardness. (kilo).....	3.62	3.20(11)	4.22(9)
Absorption of water. (%)	19.61	18.58(9)	20.44(11)
Volume of 100g. (c.c.).....	119.30	116.8(10)	121.8(10)
Weight of 1,000 grains. (g.)	22 61	21.22(12)	23.43(8)
Volume of 1,000 grains. (c.c.)	15.55	14.84(11)	16.42(9)
Water	13.34	13.01(11)	13.74(9)
D. R. sugar.....	0.45	0.34(9)	0.53(11)
Starch	90.42	90.00(9)	90.75(11)
Crude fat	0.30	0.22(11)	0.40(9)
Crude protein	7.94	7.64(12)	8.39(8)
Crude fibre .....*..	0.49	0.34(10)	0.64(10)
Ash	0.43	0.36(12)	0.53(8)
Phosphoric acid	0.21	0.20(14)	0.25(6)

Summary of the 1917 production.

Percentage of Shinziromai, specific gravity, saccharifying quality, absorption of water, weight of 1,000 grains, starch, crude fat, crude fibre, crude protein and phosphoric acid were somewhat higher than those of the production of 1916 suited for Saké brewing, while the percentage of full grown grains, depth of longitudinal furrow, hardness, volume of 100 g, thickness of bran layer, depth of embryo cavity, water, sugar and ash were lower when compared with those of 1916 suited for Saké brewing.

1918 Production.

a) Husked rice, suitable for the Saké brewing. 21 (A–U) varieties.

A) *Production of Okayama prefecture.*

a) Percentage of full grown grains.——91.2%

b) External appearance and luster.——Straw yellow waxy luster, grains were fat and large.

c) Size of grains (m.m.)

thickness above	2 2	86.97 g.	44 grains
// //	2.0	9.92 //	5 //
// //	1.8	2.07 //	1 //
// //	1 6	0.22 //	—
// under	1.6	—	—
	average.	max.	min
length	5.36	5.70	5 00
width	3 08	3.25	2.70

d) Percentage of Shinziromai.——70.40%

e) Depth of longitudinal furrow. (μ)

average	max.	min.
35.81	51.90	17.30

f) Specific gravity.——1.399

h) Hardness. (kilo)

under 3.75		7 grains.
3.75—5.63		21 //
5.63—7.50		21 //
7.50—9.38		1 //
above 9.38		—
average	max.	min.
5.30	8.03	2.93

i) Volume of 100g.——121.5c.c.

j) Weight of 1,000 grains.——27.80g.

k) Volume of 1,000 grains.——19.70c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
43.59	49 05	40.05

n) Absorption of water.

time steeped.	% absorbed.
24 h.	22.0

p) Chemical composition :—

		unhydrous
Water	12.96	—
D. R. sugar	0.75	0.86
Starch	74 69	85.89
Crude fat	7.48	2.86
// protein	7.85	9.02
Ash	1.30	1.50

B) *Production of Okayama prefecture.*

a) Percentage of full grown grains.——87.5%

b) External appearance and luster.——Nearly same as A).

c) Size of grains. (m.m.)

thickness above	2 2	85 06 g.	43 grains.
// //	2.0	12.38 //	6 //
// //	1.8	2.32 //	1 //
// //	1.6	0 18 //	—
// under	1 6	0.07 //	—

	average.	max	min.
length	5.32	5 65	5.00
width	3.00	3.20	2 80

d) Percentage of Shinzinomai.——75.34%

e) Depth of longitudinal furrow. (μ)

average.	max.	min
40 40	60 55	20.76

f) Specific gravity. 1.403

h) Hardness. (kilo)

under 3.75	9 grains
3.75—5 63	25 //
5.63—7.50	16 //
7 50—9.38	—
above 9 38	—

average.	max.	min.
4.97	6.81	3.28

i) Volume of 100g.—— -121.0c.c.

j) Weight of 1,000 grains.——27.20g.

k) Volume of 1,000 grains. - —19.25c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
44.48	47.93	39.15

n) Absorption of water.

time steeped.	% absorbed.
24 h.	21.64

p) Chemical composition :—

		unhydrous.
Water	13.26	—
D. R. sugar	0.85	0 98
Starch	75.09	86.35
Crude fat	2.22	2.55
// protein	7.30	8.40
Ash	1 30	1.50

C) *Production of Okayama prefecture.*

a) Percentage of full grown grains.——83.5%

b) External appearance and luster.——Nearly same as B).

c) Size of grains. (m.m.)

thickness above	2.2	86.50 g.	43 grains
// //	2.0	10.08 //	5 //
// //	1.8	3.17 //	2 //
// //	1 6	0.23 //	— //
// under	1.6	0 17 //	—
	average.	max.	min.
length	5.41	5.70	5.00
width	3.09	3.30	2 80

d) Percentage of Shinziromai.--- 79.20%

e) Depth of longitudinal furrow. (μ)

average	max.	min.
38.62	57.09	20.76

f) Specific gravity.——1.399

h) Hardness. (kilo)

under 3.75		13 grains
3.75—5.63		33 //
5.63—7.50		4 //
7 50—9 38		—
above 9.38		—
average.	max.	min.
4.31	5 78	2.50

i) Volume of 100 g.---124.5c.c.

j) Weight of 1,000 grains.-- -27.85g.

k) Volume of 1,000 grains. - 19.85c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
44.15	47.03	39.60

n) Absorption of water.

time steeped.	% absorbed.
24 h.	20.64

p) Chemical composition :—

		unhydrous.
Water	12.75	—
D. R. sugar	1.50	1.73
Starch	74.91	86.14
Crude fat	1.75	2.02
" protein	7.86	9.04
Ash	1.23	1.41

D) *Production of Okayama prefecture.*

a) Percentage of full grown grains.——85.7%

b) External appearance and luster.——Nearly same as C).

c) Size of grains. (m.m.)

thickness above	2.2	85.90 g.	43 grains.
" "	2.0	11.50 "	6 "
" "	1.8	2.20 "	1 "
" "	1.6	0.25 "	—
" under	1.6	0.05 "	—

	average.	max.	min.
length	5.43	5.75	4.90
width	3.04	3.25	2.65

d) Percentage of Shinziromai.——78.3%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
42.51	65.36	20.76

f) Specific gravity.——1.403

h) Hardness. (kilo)

under 3.75	1 grains.
3.75—5.63	31 "
5.63—7.50	17 "
7.50—9.38	1 "
above 9.38	—

average.	max.	min.
5.37	8.10	3.22

i) Volume of 100g.——121.5c.c.

j) Weight of 1,000 grains.——27.55g.

k) Volume of 1,000 grains. ——19.5c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
43.22	45.90	36.68

n) Absorption of water.

time steeped.	% absorbed.
24 h.	22 34

p) Chemical composition :—

		unhydrous.
Water	12.65	—
D. R. sugar	1.05	1.19
Starch	75.36	85.91
Crude fat	2.28	2.60
" protein	7.16	8.17
Ash	1.45	1.65

E) *Korean rice.*

a) Percentage of full grown grains. 89.28%

b) External appearance and luster.——Straw yellow colour, somewhat poor of luster, grains were not fat and of middle size.

c) Size of grains. (m.m.)

thickness above	2.2	21.52 g.	11 grains
" "	2.0	51.10 "	25 "
" "	1.8	25.45 "	13 "
" "	1.6	1.94 "	1 "
" under	1.6	0.28 "	—

	average.	max.	min.
length	4.97	5.30	4.60
width	2.83	3.00	2.50

d) Percentage of Shinziromai.——56.96%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
45.97	72.66	22.49

f) Specific gravity. ——1.389

h) Hardness. (kilo)

under 3.75	12 grains.
3.75—5.63	35 "
5.63—7.50	3 "
7.50—9.38	—
above 9.33	—

average.	max.	min.
4.24	6.75	2.40

i) Volume of 100g.——126.5c.c.

j) Weight of 1,000 grains.——21.55g.

k) Volume of 1,000 grains.——15.30c.c.

m) Thickness of bran layer. (μ)

average.	max	min.
41.29	49.28	37.35

n) Absorption of water.

time steeped.	% absorbed.
24 h.	20.24

p) Chemical composition :—

		unhydrous.
Water	12.77	—
D. R. sugar	1.15	1.31
Starch	74.54	84.98
Crude fat	2.80	3.19
" protein	8.00	9.12
Ash	1.36	1.55

F) *Korean rice (Kokuryomiyako variety).*

a) Percentage of full grown grains.——94.1%

b) External appearance and luster.——Nearly same as A).

c) Size of grains. (m m.)

thickness above	2.2	52.46 g.	26 grains.
" "	2.0	38.19 "	19 "
" "	1.8	8.99 "	5 "
" "	1.6	0.43 "	—
" under	1.6	0.05 "	—

	average.	max.	min.
length	5.28	5.65	4.75
width	3 01	3.15	2.85

d) Percentage of Shinziromai.——87.60%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
57.05	83.01	34.60

f) Specific gravity.——1.409

h) Hardness. (kilo)

under 3.75	4 grains.
3 75—5.63	39 "
5.63—7.50	7 "
7 50—9.38	—
above 9.38	—

average.	max.	min.
4 80	6.88	2.85

i) Volume of 100g.——122.5c.c.

j) Weight of 1,000 grains.——25.05g.

k) Volume of 1,000 grains.——17.80c.c.

m) Thickness of bran layer. (μ)

average	max	min.
46.78	55.20	42.53

n) Absorption of water.

time steeped.	% absorbed.
24 h.	22.2

p) Chemical composition :—

		unhydrous.
Water	13.65	—
D. R. sugar	0.74	0 86

Starch	73.44	83.79
Crude fat	2 32	2.69
" protein	7.95	9.22
Ash	1.52	1.76

(G—U) omitted

Husked rice unsuitable (I—X) omitted.

1918 Production.

β) Polished rice, suitable for the Saké brewing. 21 (A—U) varieties.

A) *Production of Okayama prefecture.*

a) Percentage of full grown grains.——94.35%

b) External appearance and luster.——White glassy luster, grains were large and fat.

c) Size of grains. (m.m.)

thickness above	2.2	68.89 g.	35 grains.
" "	2.0	26.55 "	13 "
" "	1.8	4.45 "	2 "
" "	1.6	0.32 "	—
" under	1.6	0.13 "	—

	average.	max.	min.
length	5 17	5.50	4.70
width	2 96	3 20	2.65

d) Percentage of Shinziromai.——68.2%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
24.22	43.25	17.30

f) Specific gravity.——1.439

h) Hardness. (kilo)

under 3.75	25 grains.
3.75—5.63	22 "
5.63—7.50	3 "
7.50—9.38	—
above 9.38	—

average	max.	min.
3.81	6.15	2.34

i) Volume of 100g.——114.5c.c.

j) Weight of 1,000 grains.——24.90g.

k) Volume of 1,000 grains.——17.30c.c.

n) Absorption of water.

time steeped.	% absorbed.
24 h.	22.4

p) Chemical composition :—

		unhydrous.
Water	11.35	—
D. R. sugar	0.65	0.73
Starch	80.17	90.59
Crude fat	0.97	1.09
" protein	6.52	7.36
Ash	0.31	0.35

B) *Production of Okayama prefecture.*

a) Percentage of full grown grains.——94.31%

b) External appearance and luster.——Nearly same as A).

c) Size of grains. (m.m.)

thickness above	2.2	62.36 g.	31 grains
" "	2.0	32.17 "	16 "
" "	1.8	4.95 "	3 "
" "	1.6	0.66 "	—
" under	1.6	0 27 "	—
	average.	max.	min.
length	5.24	5.55	4.65
width	2.94	3 15	2.65

d) Percentage of Shinziromai.——64.24%

e) Depth of longitudinal furrow. (μ)

average.	max.	min
35.90	57.96	38.93

f) Specific gravity.——1.429%

h) Hardness. (kilo)

under 3.75	9 grains.
3 75—5.63	26 "
5.63—7.50	15 "
7.50—9.38	—
above 9.38	—

average	max.	min.
4.87	7.41	2.63

i) Volume of 100g.— —116.5c.c.

j) Weight of 1,000 grains.——25.01g.

k) Volume of 1,000 grains. - -17.5c.c.

n) Absorption of water.

time steeped.	% absorbed.
2 h.	22.0

p) Chemical composition :—

		unhydrous
Water	14.04	—
D. R. sugar	0.65	0.75
Starch	79.29	91.97
Crude fat	0.51	0.59
" protein	5.49	6.37
Ash	0.48	0.56

C) *Production of Okayama prefecture.*

a) Percentage of full grown grains. 91.1

b) External appearance and luster. - Same as A).

c) Size of grains. (m.m.)

thickness above		2.2	63.18 g.	32 grains.
〃	〃	2.0	30.75 〃	15 〃
〃	〃	1.8	5.27 〃	3 〃
〃	〃	1.6	0.60 〃	—
〃	under	1.6	0.29 〃	—

	average.	max.	min.
length	5.11	5.55	4.65
width	2.93	3.10	2.65

d) Percentage of Shinziromai — 80.60

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
29.84	51.90	8.65

f) Specific gravity. - 1.440

h) Hardness. (kilo)

under 3.75	17 grains.
3 75—5.63	31 〃
5 63—7.50	2 〃
7.50 -9.38	—
above 9.38	—

average.	max.	min.
4.17	6 01	2.75

i) Volume of 100g.- —116.0c.c.

j) Weight of 1,000 grains.- - 24.74g.

k) Volume of 1,000 grains. - 17.30c.c.

n) Absorption of water.

time steeped.	% absorbed.
2 h.	21 4

p) Chemical composition :—

		unhydrous.
Water	13.02	—
D. R sugar	1.25	1.43
Starch	78.98	90.82
Crude fat	0.57	0 65
〃 protein	5.89	6.77
Ash	0.36	0.41

D) *Production of Okayama prefecture.*

a) Percentage of full grown grains.——92.95

b) External appearance and luster.——Same as A).

c) Size of grains. (m.m.)

thickness above		2.2	61.79 g.	31 grains.
"	"	2.0	28.77 "	14 "
"	"	1.8	8.25 "	4 "
"	"	1.6	0.94 "	1 "
"	under	1.6	0.30 "	—

	average.	max.	min.
length	5.20	5.50	4.75
width	2.92	3.20	2.60

d) Percentage of Shinziromai.——63.60

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
26.81	51.90	17.30

f) Specific gravity. - —1.429

h) Hardness. (kilo)

under 3.75	11 grains
3.75—5.63	30 "
5.63—7.50	9 "
7.50—9.38	—
above 9.38	—

average	max.	min.
4.71	6.68	2.63

i) Volume of 100g.——116.0c.c.

j) Weight of 1,000 grains.— 24.24g.

k) Volume of 1,000 grains.— 16.8c.c.

n) Absorption of water.

time steeped.	% absorbed.
2 h.	22.16

p) Chemical composition :—

		unhydrous.
Water	12.89	—
D. R. sugar	0.41	0.50
Starch	78.72	89.51
Crude fat	0.38	0.43
" protein	7.20	8.27
Ash	0.33	0.38

E) *Korean rice.*

a) Percentage of full grown grains.- --86.5

b) External appearance and luster. — Nearly same as C), but grains were of middle size and not fat.

c) Size of grains. (m.m.)

thickness above		2.2	8.60 g.	4 grains.
"	"	2.0	27.38 "	14 "
"	"	1.8	60.28 "	30 "
"	"	1.6	3.16 "	2 "
"	under	1.6	0.63 "	—

	average.	max.	min.
length	4.90	5.60	4.45
width	2.72	3.10	2.35

d) Percentage of Shinziromai.— 50.7

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
30.92	51.90	17.30

f) Specific gravity.- —1.429

h) Hardness. kilo)

under 3.75	26 grains.
3.75—5.63	23 〃
5.63—7.50	1 〃
7.50—9.38	—
above 9.38	—

average.	max.	min.
3.75	6.19	2 29

i) Volume of 100g. - 116.5c.c.

j) Weight of 1,000 grains. -19.50c.c.

k) Volume of 1,000 grains. 13.6c.c.

n) Absorption of water.

time steeped.	% absorbed.
2 h.	19.9

p) Chemical composition :—

		unhydrous
Water	13.32	—
D. R. sugar	0.95	1.10
Starch	77 63	90.05
Crude fat	0.50	0.58
〃 protein	7.30	8.47
Ash	0.31	0.36

F) *Korean rice* (*Kokuryomiyako variety*).

a) Percentage of full grown grains. 86.6

b) External appearance and luster. Nearly same as A).

c) Size of grains. (m.m.)

thickness above	2 2	16.27 g.	8 grains.
〃 〃	2.0	51.79 〃	26 〃
〃 〃	1.8	30.25 〃	15 〃
〃 〃	1.6	1.55 〃	1 〃
〃 under	1.6	0.21 〃	—

	average.	max.	min.
length	5.20	5.55	4.60
width	2.94	3.10	2.60

d) Percentage of Shinziromai. - 87.0

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
41.09	69.20	17.30

f) Specific gravity.—— 1.492

h) Hardness. (kilo)

under 3.75	23 grains.
3.75—5.63	18 〃
5.63—7.50	5 〃
7.50—9.38	4 〃
above 9.38	—

average.	max	min.
4.21	8.55	2.25

i) Volume of 100g. — 114.0c.c.

j) Weight of 1,000 grains. - —22.72g.

k) Volume of 1,000 grains.— 15.70c.c.

n) Absorption of water.

time steeped.	% absorbed
2 h.	22.7

p) Chemical composition :—

		unhydrous
Water	11 85	—
D. R. sugar	0.65	0 73
Starch	79 90	90.28
Crude fat	0.29	0.33
〃 protein	6 99	7 90
Ash	0 34	0.39

(G—U) omitted.

Polished rice unsuitable (I—X) omitted.

β′) Polished rice unfit for the Saké brewing.

I′) *Langoon rice.*

a) Percentage of full grown grains.- —51.1

b) External appearance and luster.— Greyish white colour, destitute of luster, grains were of middle size, abundant impurities were perceived.

c) Size of grains. (m.m.)

thickness above	2.2	7.68 g.	4 grains.
〃 〃	2.0	17.66 〃	9 〃
〃 〃	1.8	46.64 〃	23 〃
〃 〃	1 6	17.60 〃	9 〃
〃 under	1.6	10.28 〃	5 〃

	average.	max.	min.
length	5.43	6.00	5.00
width	2.59	3 10	1.90

d) Percentage of Shinziromai.——36.20

f) Specific gravity. — 1.429

h) Hardness. (kilo)

under 3.75	29 grains.
3.75—5.63	20 "
5.63—7.50	1 "
7.50—9.38	—
above 9.38	—

average.	max.	min.
3.65	6.00	2.06

i) Volume of 100g. — 122.5c.c.

j) Weight of 1,000 grains. - —20.5g.

k) Volume of 1,000 grains. - -13.65c.c.

n) Absorption of water.

time steeped.	% absorbed.
2 h.	17.91

p) Chemical composition :—

		unhydrous.
Water	12.96	—
D. R. sugar	0.44	0.50
Starch	79.73	90.89
Crude fat	0.48	0.55
" protein	6.01	6.85
Ash	0.43	0.49

II') *Saigon rice.*

a) Percentage of full grown grains. 40.75

b) External appearance and luster. Nearly same as before, but grains were more slender than the former and the impurities were abundant.

c) Size of grains. (m.m.)

thickness above	2.2	3.40 g.	2 grains.
" "	2.0	10.86 "	5 "
" "	1.8	45.41 "	23 "
" "	1.6	23.73 "	12 "
" under	1.6	16.38 "	8 "

	average.	max.	min.
length	5.52	5.80	4.90
width	2.42	2.80	1.90

d) Percentage of Shinziromai.- 29.86

f) Specific gravity. —1.429.

h) Hardness. (kilo)

under 3.75	14 grains.
3.75—5.63	30 "
5.63—7.50	6 "
7.50—9.38	—
above 9.38	—

average.	max.	min.
4.18	6.56	2.34

TABLE VII. 1918 Husked rice.

(Suitable for the Saké brewing.)

	% of full grown grains.	% of Shinziroumai	Depth of longitudinal furrow. (μ)	Specific gravity	Hardness. (kilo)	Volume of 100 g. (c c.)	Weight of 1,000 grains. (g.)	Volume of 1,000 grains. (c c.)	Thickness of bran layer (μ)	Water	D. R. sugar	Starch	Crude fat	Crude protein	Ash
A	91.2	70.40	35.81	1.40	5.30	121.5	27.80	19.70	43.59	12.94	0.86	85.89	2.86	9.02	1.50
B	87.5	75.34	40.40	1.40	4.97	121.0	27.20	19.25	44.48	13.26	0.98	86.35	2.55	8.60	1.50
C	83.5	79 20	38.62	1.40	4.31	124.5	27.85	19.85	44.15	12.75	1.71	85.62	2.00	8.98	1.41
D	85.7	78.30	42.51	1.40	5 37	121.5	27.55	16.50	43.22	12.65	1.19	85.91	2.60	8.17	1.65
E	89.28	56.96	45.97	1.39	4.24	126.5	21.55	15.30	41.29	12.17	1.31	84.98	3.19	9.12	1.55
F	94.10	87.60	57.05	1.41	4.80	122.5	25.05	17.80	46.78	13.65	0.87	85.41	2.74	9.24	1.76
G	86.45	76.50	45.41	1.40	4.92	129.5	25.30	17.90	55.04	11.89	0.96	85.93	2.08	8.93	2.09
H	96.15	89.60	48.92	1.40	3.96	127.0	25 71	18.60	44.26	12.16	1.19	86.87	2.41	10.17	1.40
I	95.25	90.07	44.72	1 40	3.53	127.5	21.20	18.75	45.72	12.53	1.42	86.85	1.78	8.87	1.16
J	89.10	75.20	42.86	1.40	4.58	126.0	24.90	17.80	46.77	12.25	1.08	86.20	2.87	8.26	1.70
K	90.05	73.00	46.41	1.41	5.31	125 0	24.45	17.30	50.50	12.45	1.08	87.10	1.92	8.04	1.87
L	94.45	83.40	45.93	1.39	3.82	127.0	25.15	18.00	48.69	12.83	0.98	86.77	2.05	8.60	2.54
M	88.95	79 10	39.05	1.41	5.19	122.0	27.23	16.90	5 .10	13.87	1.10	85.89	2.94	9.01	1.17
N	85.82	75.10	39.05	1.40	5.25	120.5	24.60	17.60	50.10	12.31	0.97	87.79	1.37	8.20	2.02
O	86.75	86.46	37.58	1.41	5.02	121.0	28.60	20.30	47.07	12.06	0.85	84.35	2.78	10.35	1.65
P	92.62	87.20	49.26	1.41	4.30	124.0	27.25	19.40	48.85	12.11	1.24	84.67	3.02	9.08	2.00
Q	92.10	84.60	46.06	1.40	4.18	125.5	26.75	19.20	51.48	12.06	1.30	86.47	2.42	8.12	1.76
R	88.80	63.30	46.45	1.40	4.54	128.0	23.70	17.00	49.95	11.41	1.41	84.86	3.29	9.17	1.31
S	94.50	29.50	46.58	1.41	4.71	129.0	21.45	15.20	44.25	12.30	1.19	85.91	2.48	8.82	1.18
T	91.00	61.84	51.39	1.49	4.05	128.5	23.65	17.00	49.25	10.76	1.76	85.40	2.88	9.67	1.31
U	94.87	51.26	53.54	1.40	4.18	124.0	25.05	17.00	49.77	12.18	1.13	84 36	2.94	10.22	1.27

TABLE VIII. 1918 Polished rice.

(Suitable for the Saké brewing.)

	% of full grown grains.	% of Shiniziromai	Depth of longitudinal furrow. (μ)	Specific gravity	Hardness. (kilo)	Volume of 100 g. (c c)	Weight of 1,000 grains (g.)	Volume of 1,000 grains. (c c.)	Water	D. R. Sugar	Starch	Crude fat	Crude protein	Ash	Absorption of water. (%)
A	94.35	68.20	24.22	1.44	3.81	114.5	24.90	17.30	11.35	0.73	90.59	1.09	7.36	0.35	22.40
B	94.31	80.60	29.84	1.44	4.17	116.0	24.74	17.30	13.02	1.43	90.82	0.65	6.77	0.41	21.40
C	91.10	63.60	26.81	1.43	4.71	116 0	24.24	16.80	12.89	0.50	90.29	0.43	8.36	0.38	22.16
D	92.95	64.24	35.90	1.43	4.87	116.5	25.01	17.50	13.64	0.76	91.73	0.59	6.35	0.56	22.00
E	86.50	50.70	30.92	1.43	3.75	116.5	19.50	13.60	13 32	1.09	89.58	0.58	8.43	0.39	19.90
F	86.60	87.00	41.09	1.49	4.21	114.0	22.72	15.70	11.85	0.73	90.28	0.33	7.90	0.45	22.70
G	85.78	60.50	36.93	1.45	4.44	113.5	23.35	16.10	12.54	0.63	90.75	0.32	7.46	0.44	20.50
H	93.95	89.44	36.76	1.44	3.82	115.0	23.62	16.70	11.00	0.73	90.42	0.41	7.79	0.37	18.80
I	92.92	88.70	35.90	1.44	3.91	118.0	23 64	16.60	12.14	0.63	92.26	0.38	6.48	0.61	18.10
J	95.30	58.60	35.47	1.43	3.80	124.5	22.15	15.40	12.71	0.87	90.50	0.41	7.91	0.45	18.94
K	94.00	54.64	26.60	1.43	4.54	119.0	21.33	14.70	12.51	0.86	91.09	0.38	7.19	0.34	19.20
L	90.14	71.86	29.63	1.42	2.57	120.0	23.12	16.10	11.68	0.85	91.18	0.49	6.95	0.63	16.00
M	93.35	61.54	33.30	1.45	4.53	—	24.72	17.00	12.04	1.31	90.21	0.55	7.22	0.38	19.80
N	88.30	84.50	37.41	1.45	4.53	122 0	23.10	16.00	11.27	0.62	91.01	0.69	7.22	0.64	20.74
O	86.30	78.00	22.71	1.45	3.68	117.0	25.20	17.40	11.01	0.95	89.88	0.88	7.74	0.46	22.28
P	92.35	78.80	27.90	1.44	4.63	121.0	24.72	17.20	12.34	0.85	90.27	0.49	7.93	0.71	19.10
Q	95.58	88.30	28.33	1.44	4.29	122.5	25.12	17.40	10.72	0.73	89.39	0.33	8.93	0.86	18.46
R	85.25	60.44	29.41	1.43	4.66	124.0	21.80	19.20	12.64	0.96	90.53	0.23	6.98	0.58	19.00
S	92.33	31.00	38.28	1.44	2.17	120.5	19.98	13.80	13.38	0.86	90.17	0.77	7.88	0.53	17.84
T	91.60	51.28	45.54	1.42	3.50	123.5	21.42	15.00	12.71	0.51	90.17	0.60	8.65	0.56	17.26
U	92.55	50.90	33 74	1.44	3.19	120.5	22.42	15.60	12.15	0.38	91.15	0.64	7.23	0.64	17.30

TABLE IX. 1918 Husked rice.

(Unsuitable for the Saké brewing.)

	% of full grown grains.	% of Shinzironnai.	Depth of longitudinal furrow. (μ)	Specific gravity	Hardness. (kilo)	Volume of 100 g (c c.)	Weight of 1,000 grains (g)	Volume of 1,000 grains (c c)	Thickness of bran layer. (μ)	Water	D. R. sugar	Starch	Crude fat	Crude protein	Ash
I	86.05	49.23	55.01	1.40	5.40	129.0	23.15	16.50	43.98	12 43	1.08	82.89	2.98	11 26	1.62
II	91.15	61.30	47.02	1.40	4.38	125 0	22.50	16.10	43.22	12.50	1.42	84.45	2.52	10.13	1.47
III	84.10	78.60	43.19	1.41	4.97	128.5	23 70	16.90	52.76	10.39	1.05	86.73	2.25	8.55	1.43
IV	66 70	53.60	45 24	1.39	4.87	130 0	21.15	15 10	45.91	14.56	0 99	87.19	1.47	8.29	1.54
V	82.40	61.10	45.72	1.38	4.69	129.0	23.00	16.60	52 92	13.56	2.15	85.68	2.34	8.63	1.18
VI	77.10	49.20	35.81	1.39	5.09	128.0	23.75	16.90	49.34	13.42	2.02	85 87	2.18	8.69	1.25
VII	71.50	72.40	48.14	1.39	4 31	133.0	23.13	16.50	52.12	11.46	1.07	83.77	3.72	9.39	2.08
VIII	88.45	42.20	47.96	1.39	4.47	130.5	19.95	16.20	40.19	12.53	1.08	86.33	2.30	8.87	1.50
IX	83.75	52.60	41.13	1.41	5.13	124 5	22.32	15.85	45.69	12.23	0.96	87.26	2.03	8.28	1.55
X	80.85	71.20	56.10	1.41	5 08	131.5	21.45	15 30	52.62	11.87	1.07	85.61	2.26	8.94	1.99

TABLE X. 1918 Polished rice.

Unsuitable for the Saké brewing.

	% of full grown grains.	% of Shinziromai	Depth of longitudinal furrow. (μ)	Specific gravity	Hardness. (kilo)	Volume of 100g. (c.c.)	Weight of 1,000 grains. (g.)	Volume of 1,000 grains. (c.c.)	Water	D. R. sugar	Starch	Crude fat	Crude protein	Ash	Absorption of water (%)
I	88.20	39.00	46.71	1.44	4 10	122.0	20.92	14.50	12.34	0.86	89.51	0.53	8.86	0.35	19.05
II	93.95	53.00	35.90	1.42	4.07	121.0	20.25	14.10	11.34	0.50	88.75	0.90	9.68	0.53	26.40
III	78.45	54.64	42.17	1.43	4.00	121.0	21.70	15.00	11.63	0.62	90.36	0.44	7.70	0.68	—
IV	86.02	45.00	28.76	1.43	3.67	122.0	19.68	13.70	12.04	0.98	90.38	0.92	7.28	0.67	19.90
V	86.75	65.40	37.63	1.43	4.04	133.0	21.70	15.10	12.30	0.71	91.00	0.74	7.32	0 56	19.10
VI	87.65	46.14	29.19	1.43	4.40	122.5	22 56	15.70	10.67	0.88	90.69	0.43	7.83	0.55	20.00
VII	86 62	63.70	32.44	1.42	3.67	122.5	20 32	14 20	11.43	0.84	89.89	0.54	8.19	0.62	18.00
VIII	95.40	40.40	39.36	1.43	2.75	123.5	17.75	12.30	12.10	0.51	91.55	0.27	7.24	0.64	16.00
IX	63.30	35 24	28.01	1.44	3.91	124.0	20.90	14.50	12 12	0.62	91 23	0.56	7.18	0.70	19.40
X	92.22	55.48	46.06	1.44	4.63	126.0	19.85	13 80	12.85	0.50	90.85	0.26	8.21	0.39	17 90
I′	51.10	36.20	—	1.43	3.56	122 5	20.50	13.65	12.96	0.50	80.89	0.55	6.85	0.49	17.94
II′	40.75	29.86	—	1 43	4.18	121.0	18.90	13.30	11.28	0.50	90.78	0.33	8.06	0.56	16.20

i) Volume of 100g.——121.0c.c.

j) Weight of 1,000 grains.——18.90g.

k) Volume of 1,000 grains.——13.3c.c.

n) Absorption of water.

time steeped.	% absorbed.
2 h.	16.2

p) Chemical composition.——

		unhydrous.
Water	11.28	—
D. R. sugar	0.45	0.50
Starch	80.34	90.78
Crude fat	0.29	0.33
" protein	7.14	8.06
Ash	0.50	0.56

Summary of the 1918 production.

In the suitable materials for the Saké brewing, percentages of full grown grains, and shinziromai, size of grains, specific gravity, both volume and weight of 1,000 grains and starch showed a higher value than the unsuitable, while depth of longitudinal furrow, volume of 100 g. thickness of bran layer, water, sugar, crude fat, crude protein and ash showed a smaller value. External appearance and luster should be fine.

1919 Production.

α) Husked rice, suitable for the Saké brewing. 19 (A–S) varieties.

A) *Production of Okayama prefecture.*

a) Percentage of full grown grains.——90.0

b) External appearance and luster.——Light straw yellow waxy luster, grains were fat and large. (1st class).

c) Size of grains. (m.m.)

thickness above	2.2	77.60 g.	39 grains.
" "	2.0	17.25 "	9 "
" "	1.8	4.80 "	2 "
" under	1.8	0.30 "	— "

	average.	max.	min.
length	5.04	5.80	5.00
width	3.02	3.30	2.65

d) Percentage of Shinziromai.——13.3

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
57.52	95.15	25.95

f) Specific gravity.——1.418

h) Hardness. (kilo)

average.	max.	min.
6 07	9.38	3.90

i) Volume of 100g.——121.0c.c.

j) Weight of 1,000 grains. - 26.9g.

k) Volume of 1,000 grains.- - -19.0c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
33.30	60.55	17.30

p) Chemical composition.—

Water	12 46
Starch	72.03
Sugar	0.71
Crude protein	8.52
" fat	2.24
Ash	1.28

B) *Production of Hyogo prefecture.*

a) Percentage of full grown grains. - -98.6

b) External appearance and luster.——Nearly same as the former (lst class).

c) Size of grains. (m.m.)

thickness	above	2.2	77.70 g.	39 grains.
"	"	2.0	19.90 "	10 "
"	"	1.8	2.40 "	1 "
"	under	1.8	0.10 "	—
		average.	max.	min.
	length	5.38	5.70	4.90
	width	3.12	3.55	2.90

d) Percentage of Shinziromai.——91.6%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
57.31	86.50	34.60

f) Specific gravity. 1.399

h) Hardness. (kilo)

average.	max.	min.
4.80	7.69	3.43

i) Volume of 100g. - -125.0c.c.

j) Weight of 1,000 grains.——27.1g.

k) Volume of 1,000 grains.——19.4c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
42.22	47.03	37.80

p) Chemical composition :—

Water	14.23
Starch	74.12
Sugar	0.90
Crude protein	10.13
" fat	1.72
Ash	1.03

C) *Production of Hyogo prefecture.*

a) Percentage of full grown grains. - 98.3

b) External appearance and luster. —— Same as B).

c) Size of grains. (m.m.)

thickness	above.	2 2	55.5 g.	28 grains.
"	"	2.0	39.2 "	20 "
"	"	1.8	5.3 "	2 "
"	under	1.8	0 "	—
		average.	max.	min.
	length	5.29	5.70	4.80
	width	3.17	3.40	3.00

d) Percentage of Shinziromai.——92.6

e) Depth of longitudinal furrow. (μ)

average.	max	min.
59.25	86.50	34 60

f) Specific gravity.——1.399

h) Hardness. (kilo)

average.	max.	min.
5.63	10 80	4.09

i) Volume of 100g.——121.0c.c.

j) Weight of 1,000 grains.——26.4g.

k) Volume of 1,000 grains. - —18,7c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
44.35	51.08	40.95

p) Chemical composition :—

Water	11.95
Starch	70.08
Sugar	1.53
Crude protein	9.69
" fat	1.94
Ash	1.19

D) *Production of Osaka prefecture.*

a) Percentage of full grown grains.——97.0

b) External appearance and luster.——Same as B)

c) Size of grains. (m.m.)

thickness	above	2.2	83.15 g.	42 grains.
〃	〃	2 0	14.55 〃	7 〃
〃	〃	1.8	2 25 〃	1 〃
〃	under	1 8	0.05 〃	—
		average.	max.	min.
	length	5 34	5.65	5 10
	width	3 15	3.35	2.90

d) Percentage of Shinziromai.- 80.7

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
53.85	86 50	34.60

f) Specific gravity.——1.409

h) Hardness. (kilo)

average.	max	min
4 64	7.88	3.26

i) Volume of 100g.——124.0c.c.

j) Weight of 1,000 grains.——27.3g.

k) Volume of 1,000 grains. 19.3c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
53.85	86.50	34.60

p) Chemical composition.—

Water	12.82
Starch	73.05
Sugar	0.83
Crude protein	9.25
〃 fat	1.51
Ash	0.95

E) *Production of Saga prefecture.*

a) Percentage of full grown grains.——93.4

b) External appearance and luster.——Same as A)

c) Size of grains. (m.m.)

thickness	above	2.2	56.55 g.	28 grains.
〃	〃	2.0	35.50 〃	18 〃

〃	〃	1.8	7.15 〃	4 〃
〃	under	1.8	0.60 〃	—

	average.	max.	min.
length	5.15	5.50	4.90
width	3 09	3.25	2.90

d) Percentage of Shinziromai.—— 5.8

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
59.25	86.50	34.60

f) Specific gravity.— 1.409

h) Hardness. (kilo)

average.	max.	min.
6.12	9.28	3.45

i) Volume of 100g. ——125.0c.c.

j) Weight of 1,000 grains.——24.45g.

k) Volume of 1,000 grains.—— 17.15c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
41.34	45.45	31.73

p) Chemical composition :—

Water	12.94
Starch	72.09
Sugar	0.65
Crude protein	9.11
〃 fat	2.40
Ash	1.29

F) *Production of Kumamoto prefecture.*

a) Percentage of full grown grains.——96.5

b) External appearance and luster.——Same as before.

c) Size of grains. (m.m.)

thickness	above	2.2	65.50 g.	33 grains.
〃	〃	2.0	26.60 〃	13 〃
〃	〃	1.8	7.20 〃	4 〃
〃	under	1.8	0.60 〃	—

	average.	max.	min.
length	5.12	5.45	4.85
width	3.09	3.35	2.75

d) Percentage of Shinziromai.——4.6

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
54.71	86.50	17.30

f) Specific gravity.——1.399

h) Hardness. (kilo)

average.	max.	min.
6 17	9.04	3.75

i) Volume of 100g.——122.0c.c.

j) Weight of 1,000 grains. -24.8g.

k) Volume of 1,000 grains. --17.7c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
39.88	45.23	33.08

p) Chemical composition :—

Water	13.87
Starch	74.28
Sugar	0.71
Crude protein	8.82
〃 fat	1.96
Ash	1.23

G) *Production of Hiroshima prefecture.*

a) Percentage of full grown grains.——93.3

b) External appearance and luster.——Same as B).

c) Size of grains. (m.m.)

thickness above	2.2	75.70 g.	38 grains.
〃 〃	2.0	18.90 〃	10 〃
〃 〃	1.8	4.75 〃	2 〃
〃 under	1.8	0.65 〃	— 〃

	average.	max.	min.
length	5.21	5.60	4.90
width	3.09	3.35	2.90

d) Percentage of Shinziromai.——47.10%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
49.31	69.20	25.95

f) Specific gravity.——1.399

h) Hardness. (kilo)

average.	max.	min.
5.22	7.69	3.56

i) Volume of 100g.——124.0c.c.

j) Weight of 1,000 grains.——25.6g.

k) Volume of 1,000 grains.——18.1c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
42.33	55.13	36.23

p) Chemical composition :—

Water	12.80
Starch	71.98
Sugar	0.77
Crude protein	9.69
" fat	2.18
Ash	1.21

H) *Production of Okayama prefecture.*

a) Percentage of full grown grains.——83.7

b) External appearance and luster.——Nearly same as G).

c) Size of grains. (m.m.)

thickness above	2.2	23.00 g.	11 grains.
" "	2.0	51.70 "	26 "
" "	1 8	23.35 "	12 "
" under	1.8	1.95 "	1

	average.	max	min.
length	5.14	5.55	4.65
width	2.89	3.15	2.65

d) Percentage of Shinziromai.——1.5

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
53.20	86.50	17.30

f) Specific gravity.——1.385

h) Hardness. (kilo)

average.	max.	min.
5.83	7.61	3.26

i) Volume of 100g.——124.0c.c.

j) Weight of 1,000 grains. ——24.2g.

k) Volume of 1,000 grains.——17.1c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
43.29	49 28	36 00

p) Chemical composition :—

Water	12.86
Starch	70.74
Sugar	0.90
Crude protein	7.34
" fat	2.10
Ash	1.21

I) *Production of Yamaguchi prefecture.*

a) Percentage of full grown grains. 92.8

b) External appearance and luster.——Same as II).

c) Size of grains. (m.m.)

thickness above	2.2	78.40 g.	39 grains.
" "	2.0	17.50 "	9 "
" "	1 8	3.55 "	2 "
" under	1.8	0.?5 "	—

	average.	max.	min.
length	5.34	5.70	4 95
width	3 07	3.25	2.90

d) Percentage of Shinziromai.——9.5%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
47.79	86.50	17.30

f) Specific gravity.——1.404

h) Hardness. (kilo)

average.	max.	min.
6.50	10.14	3.38

i) Volume of 100g.——120.5c.c.

j) Weight of 1,000 grains.——26.6g.

k) Volume of 1,000 grains.——18.75c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
42.55	47.25	36.68

p) Chemical composition :—

Water	12.94
Starch	72.99
Sugar	0.90
Crude protein	9.10
〃 fat	2.06
Ash	1.04

J) *Production of Niigata prefecture.*

a) Percentage of full grown grains.——95.3

b) External appearance and luster.——Straw yellow colour, grains were fat and of middle size, but somewhat poor of luster (2nd class).

c) Size of grains. (m.m.)

thickness above	2.2	23.0 g.	11 grains.
〃 〃	2.0	51.7 〃	26 〃
〃 〃	1.8	23.35 〃	12 〃
〃 under	1.8	1.95 〃	1

	average.	max.	min.
length	5.14	5.55	4.65
width	2.89	3.15	2.65

d) Percentage of Shinziromai.——0.6

e) Depth of longitudinal furrow. (μ)

average	max.	min.
44.33	95.15	17.30

f) Specific gravity.——1.389

h) Hardness. (kilo)

average.	max.	min.
5.55	7.13	4.03

i) Volume of 100g.——129.0c.c.

j) Weight of 1,000 grains.——22.4g.

k) Volume of 1,000 grains.——16.0c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
44.33	95.15	17.30

p) Chemical composition :—

Water	13.89
Starch	70.43
Sugar	0.65
Crude protein	8.81
〃 fat	2.00
Ash	1.08

K) *Production of Aichi prefecture.*

a) Percentage of full grown grains.——93.5

b) External appearance and luster.——Same as J).

c) Size of grains. (m.m.)

thickness above	2.2	63.95 g.	32 grains.
〃 〃	2.0	28.70 〃	15 〃
〃 〃	1.8	6.80 〃	3 〃
〃 under	1.8	0.55 〃	—

	average.	max.	min.
length	5 10	5.50	4.90
width	3.03	3.15	2.90

d) Percentage of Shinziromai.——3.2

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
47.58	86.50	17.30

f) Specific gravity.——1.413

h) Hardnesss. (kilo)

average.	max.	min.
6.25	8.74	3.68

i) Volume of 100g.——121.0c.c.

j) Weight of 1,000 grains.——24.2g.

k) Volume of 1,000 grains.——17.1c.c.

m) Thickness of bran layer. (μ)

average.	max.	min
42.29	48.60	36.23

p) Chemical composition :—

Water	12.94
Starch	71.40
Sugar	1.53
Crude protein	9.69
" fat	2.30
Ash	1 34

L) *Production of Miye prefecture.*

a) Percentage of full grown grains. 95.3

b) External appearance and luster.——Same. as B).

c) Size of grains. (m.m.)

Thickness above	2.2	76.4 g.	38 grains.
" "	2.0	17.8 "	9 "
" "	1.8	5.3 "	3 "
" under	1 8	0.6 "	—

	average.	max.	min.
length	5.30	5.70	4.80
width	3.03	3.30	2.85

d) Percentage of Shinziromai——19.3

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
45.41	69.20	25.95

f) Specific gravity.—— 1.404

h) Hardness. (kilo)

average.	max.	min.
5.22	8.51	3.38

i) Volume of 100g.——121.0c.c.

j) Weight of 1,000 grains.——26.2g.

k) Volume of 1,000 grains.——18.5c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
45.41	69.20	25.95

p) Chemical composition :—

Water	12.55
Starch	73.51
Sugar	0.32
Crude protein	8.52
" fat	2.17
Ash	1.06

M) *Production of Yehime prefecture.*

a) Percentage of full grown grains.——96.9

b) External appearance and luster.—— same as A).

c) Size of grains. (m.m.)

thickness above	2.2	81.36 g.	41 grains.
" "	2.0	16.10 "	8 "
" "	1.8	2.30 "	1 "
" under	1.8	0.30 "	—

	average.	max.	min.
length	5.47	5.90	5.00
width	3.09	3.35	2.85

d) Percentage of Shinziromai. — 21.8

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
48.22	77.85	25.95

f) Specific gravity. —1.409

h) Hardness. (kilo)

average.	max.	min.
5.34	9.19	3.84

i) Volume of 100g. - 120.0c.c.

j) Weight of 1,000 grains. - 27.1g.

k) Volume of 1,000 grains.——19.4c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
42.12	47.70	35.33

p) Chemical composition :—

Water	12.70
Starch	71.43
Sugar	1.53
Crude protein	9.11
" fat	2.25
Ash	1.08

N) *Production of Kagawa prefecture.*

a) Percentage of full grown grains.——96.5%

h) External appearance and luster.——Same as M).

c) Size of grains. (m.m.)

thickness above	2.2	88.0 g.	44 grains.
〃 〃	2.0	11.0 〃	6 〃
〃 〃	1.8	0.90 〃	— 〃
〃 under	1.8	0.05 〃	—
	average.	max.	min.
length	5.44	5.85	5.00
width	3.11	3.40	2 95

d) Percentage of Shinziromai.– 20.2

e) Depth of longitudinal furrow. (μ)

average	max.	min.
38 49	60.55	17.30

f) Specific gravity.——1.413

h) Hardness. (kilo)

average.	max.	min.
5.98	8.74	3.84

i) Volume of 100g.——123.0c.c.

j) Weight of 1,000 grains.——27.8g.

k) Volume of 1,000 grains.——19.8c.c.

m) Thickness of bran layer. (μ)

average.	max	min.
44.02	50.85	38.03

p) Chemical composition :—

Water	12.67
Starch	72.88
Sugar	1.02
Crude protein	8.22
〃 fat	2.33
Ash	1.08

O) *Production of Yelime prefecture.*

a) Percentage of full grown grains.——96.7

b) External appearance and luster.——Same as N).

c) Size of grains. (m.m.)

thickness above.	2.2	54.85 g.	27 grains.
〃 〃	2.0	35.10 〃	18 〃
〃 〃	1.8	9.30 〃	5 〃
〃 under	1.8	0.60 〃	— 〃
	average	max.	min.
length	5.34	5.65	5.00
width	3.06	3.30	2.85

d) Percentage of Shinziromai.——26.3

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
52.98	77.85	34.60

f) Specific gravity.——1.415

h) Hardness. (kilo)

average.	max.	min.
5.80	9.53	3.75

i) Volume of 100g.——120.5c.c.

j) Weight of 1,000 grains.——25.35g.

k) Volume of 1,000 grains.——17.8c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
44.02	50.85	38.03

p) Chemical composition :—

Water	12.06
Starch	72.77
Sugar	1.15
Crude protein	7.64
〃 fat	2.18
Ash	1.16

P) *Production of Miyagi prefecture.*

a) Percentage of full grown grains.——96.5

b) External appearance and luster. — Yellowish brown colour, poor of luster.

c) Size of grains. (m.m.)

thickness above	2.2	70.90 g.	36 grains.
〃 〃	2.0	22.40 〃	11 〃
〃 〃	1.8	5.90 〃	3 〃
〃 under	1.8	0.70 〃	—

	average.	max.	min.
length	5.27	5.65	4.85
width	3.06	3.30	2.90

d) Percentage of Shinziromai.——3.6

e) Depth of longitudinai furrow. (μ)

average.	max.	min.
50.17	86.50	17.30

f) Specific gravity.- —1.389

h) Hardness. (kilo)

average.	max.	min.
3.61	6.34	2.57

i) Volume of 100g. 130.5c.c.

j) Weight of 1,000 grains.——25.35g.

k) Volume of 1,000 grains.——18.10c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
42.68	49.50	39.60

p) Chemical composition :—

Water	15.20
Starch	73.11
Sugar	0.77
Crude protein	8.59
" fat	2.09
Ash	1.24

Q) *Production of Fukushima prefecture.*

a) Percentage of full grown grains.——94.4

b) External appearance and luster.——Nearly same as P).

c) Size of grains. (m.m.)

thickness above	2.2	50.20 g.	25 grains.
" "	2.0	38.20 "	19 "
" "	1 8	10.45 "	5 "
" under	1.8	0.90 "	1 "

	average.	max.	min.
length	5.12	5.55	4.80
width	3.09	3.40	2 85

d) Percentage of Shinziromai. - 6.6

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
55 14	86 50	17.30

f) Specific gravity. —1,389

h) Hardness. (kilo)

average.	max.	min.
3.88	6.96	2.63

i) Volume of 100g. — 133.0c.c.

j) Weight of 1,000 grains.- 22.7g.

k) Volume of 1,000 grains. 16.9c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
41.56	45.00	35.78

p) Chemical composition :—

Water	14.89
Starch	73.55
Sugar	1.53
Crude protein	7 05
" fat	0.73
Ash	0.90

R) *Production of Fukushima prefecture.*

a) Percentage of full grown grains.——96.2

b) External appearance and luster.——Same as P).

c) Size of grains. (m.m.)

thickness above		2 2	53.25 g.	27 grains.
〃	〃	2 0	38.40 〃	19 〃
〃	〃	1.8	7.40 〃	4 〃
〃	under	1.8	0.65 〃	—
		average.	max.	min.
	length	5.23	5.55	4.80
	width	2.95	3.15	2.75

d) Percentage of Shinziromai. —1.8%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
47.79	69.20	17.30

f) Specific gravity.—— 1.389

h) Hardness. (kilo)

average.	max.	min.
4 03	5.66	2 68

i) Volume of 100g.——132.0c.c.

j) Weight of 1,000 grains.—— 23.15g.

k) Volume of 1,000 grains. - -16.4c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
43.34	47.25	39.38

p) Chemical composition :—

Water	14.73
Sarch	72.59
Sugar	1.35
Crude protein	8 37
〃 fat	1.01
Ash	1.71

S) *Production of Fukushima prefecture.*

a) Percentage of full grown grains.——90.2

b) External appearance and luster.——Nearly same as R).

c) Size of grains. (m.m.)

thickness above		2.2	79.40 g.	40 grains.
〃	〃	2.0	14.10 〃	7 〃
〃	〃	1 8	5.25 〃	3 〃
〃	under	1.8	2.10 〃	—
		average.	max.	min.
	length	4 84	5.15	4.50
	width	3 08	3.30	2.80

d) Percentage of Shinziromai.——1.8

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
43.90	69.20	17.30

f) Specific gravity.——1.389

h) Hardness. (kilo)

average.	max.	min.
4.26	6.38	2.94

i) Volume of 100g. ——131.5c.c.

j) Weight of 1,000 grains.——23.65g.

k) Volume of 1,000 grains.——17.0c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
44.30	49 50	36.45

p) Chemical composition :—

Water	15.19
Starch	73 51
Sugar	0.32
Crude protein	8.15
" fat	0.60
Ash	1.22

β) Polished rice, suitable for the Saké brewing. 19 (A–S) varieties.

A) *Production of Okayama prefecture.*

b) External appearance and luster.—— White glassy luster, grains were fat and large. (lst class).

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
33.30	60.55	17·30

h) Hardness. kilo)

average.	max.	min.
4 17	8.06	2.62

p) Chemical composition :—

Water	13.90
Starch	76.37
Sugar	0.90
Crude protein	7.49
" fat	0.43
Ash	0.39

B) *Production of Hyogo prefecture.*

b) External appearance and luster.——Nearly same as A).

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
38.28	77.85	25.95

h) Hardness. (kilo)

average.	max.	min.
4.02	9.94	2.44

p) Chemical composition :—

Water	14.90
Starch	73.43
Sugar	0.41
Crude protein	8.54
" fat	0.24
Ash	0.29

C) *Production of Hyogo prefecture.*

b) External appearance and luster.—— Same as B).

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
40.22	69.20	17.30

h) Hardness. (kile)

average	max.	min.
4.06	7.41	2.36

p) Chemical composition :—

Water	13.70
Starch	77.53
Sugar	0.86
Crude protein	8.18
" fat	0.13
Ash	0.30

D) *Production of Osaka prefecture.*

b) External appearance and luster. – Same as before.

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
31.57	51.90	17.30

h) Hardness. (kilo)

average.	max.	min.
4.89	7.31	2.48

p) Chemical composition :—

Water	14.70
Starch	74.55
Sugar	0.41
Crude protein	8.18
" fat	0.21
Ash	0.35

E) *Production of Saga prefecture.*

b) External appearance and luster.——Nearly same as A).

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
32.65	51.90	17.30

h) Hardness. (kilo)

average.	max.	min.
3.92	6.38	2.36

p) Chemical composition :—

Water	14.18
Starch	72.85
Sugar	2.19
Crude protein	9.25
" fat	0 22
Ash	0.42

F) *Production of Kumamoto prefecture.*

b) External appearance and luster.--- Same as E).

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
33.30	51.90	17.30

h) Hardness. (kilo)

average.	max.	min.
3.15	5.83	2.25

p) Chemical composition :—

Water	15.30
Starch	74.95
Sugar	0.81
Crude protein	7.32
" fat	0.20
Ash	0.42

G) *Production of Hiroshima prefecture.*

b) External appearance and luster.— - Nearly same as B).

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
24.87	43.25	0

h) Hardness. (kilo)

average	max.	min.
4.13	7.22	2.36

p) Chemical composition :—

Water	15.40
Starch	75.20
Sugar	2.19
Crude protein	9.25
" fat	0.20
Ash	0.36

H) *Production of Okayama prefecture.*

b) External appearance and luster. ——Same as A).

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
30.28	51.90	17.30

h) Hardness. (kilo)

average	max.	min.
4.60	7.50	2.49

p) Chemical composition :—

Water	15.10
Starch	74.97
Sugar	1.20
Crude protein	9.47
〃 fat	0.36
Ash	0.42

I) *Production of Yamaguchi prefecture.*

b) External appearance and luster.——Same as H).

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
33.52	51.90	17.30

h) Hardness. (kilo)

average.	max.	min.
4.53	6.79	2.63

p) Chemical composition :—

Water	15.00
Starch	76.60
Sugar	0.76
Crude protein	8.37
〃 fat	0.29
Ash	0.66

J) *Production of Niigata prefecture.*

b) External appearance and luster.——Nearly same as D), but slightly brownish colour. (2nd class).

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
30.28	51.90	17.30

h) Hardness. (kilo)

average.	max.	min.
4.89	7.31	2.48

p) Chemical composition :—

Water	15.20
Starch	76.10
Sugar	1.20
Crude protein	8.54
〃 fat	0.21
Ash	0.34

K) *Production of Aichi prefecture.*

b) External appearance and luster.——Same as J).

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
23.57	51.90	17.30

h) Hardness. (kilo)

average.	max.	min.
4.25	6.66	2.42

p) Chemical composition :—

Water	14.50
Starch	73.94
Sugar	2.34
Crude protein	7.32
" fat	0.19
Ash	0.52

L) *Production of Miye prefecture.*

b) External appearance and luster.— -Same as A).

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
15.57	25.95	0

h) Hardness. (kilo)

average.	max.	min.
4.40	6.94	2.72

p) Chemical composition :—

Water	15.30
Starch	74.04
Sugar	0.71
Crude protein	8.18
" fat	0.13
Ash	0.57

M) *Production of Yehime prefecture.*

b) External appearance and luster. Same as B).

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
33.15	51.90	17.30

h) Hardness. (kilo)

average.	max.	min.
4.09	5.72	2.59

p) Chemical composition :—

Water	14.90
Starch	75.47
Sugar	1.90
Crude protein	7.02

" fat	0.24
Ash	0.33

N) *Production of Kagaya prefecture.*

b) External appearance and luster.——Same as B).

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
24.87	51.90	0

h) Hardness. (kilo).

average.	max.	min.
4.70	7.50	2.36

p) Chemical composition :—

Water	13.50
Starch	77.49
Sugar	0.90
Crude protein	7.93
" fat	0.31
Ash	0.34

O) *Production of Yehime prefecture.*

b) External appearance and luster.— Same as N).

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
38.49	69.20	17.30

h) Hardness. (kilo)

average.	max.	min.
4.46	7.03	2.74

p) Chemical composition :—

Water	13.60
Starch	73.62
Sugar	1.65
Crude protein	7.49
" fat	0.59
Ash	0.43

P) *Production of Miyagi prefecture.*

b) External appearance and luster.—— Nearly same as B).

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
38.06	69.20	17.30

h) Hardness. (kilo)

average.	max.	min.
2.71	5.51	1.88

p) Chemical composition :—

Water	15.13
Starch	75.73
Sugar	0.36
Crude protein	9.04
" fat	0.18
Ash	0.31

Q) *Production of Fukushima prefecture.*

b) External appearance and luster.——Same as E).

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
45 85	69.20	17.30

h) Hardness. (kilo)

average.	max.	min.
3.09	5.06	1 88

p) Chemical composition :—

Water	14.80
Starch	74.60
Sugar	0.36
Crude protein	9.04
" fat	0.14
Ash	0.28

R) *Production of Fukushima prefecture.*

b) External appearance and luster.——Same as Q).

e) Depth of longitudinal furrow. (μ)

average	max	min.
38.06	51.90	17 30

h) Hardness. (kilo)

average.	max.	min
3.12	4.61	1.88

p) Chemical composition :—

Water	15.60
Starch	73 94
Sugar	1.10
Crude protein	9.47
" fat	0.48
Ash	0.28

S) *Production of Fukushima prefecture.*

b) External appearance and luster.—— Same as R.

e) Depth of longitudinal furrow. (μ)

average.	max.	min
35.68	77.85	0

h) Hardness. (kilo)

average.	max.	min.
3 31	5 26	1.88

p) Chemical composition :—

Water	14.57
Starch	73.43
Sugar	0.41
Crude protein	9.04
" fat	0.27
Ash	0.30

α') Husked rice, unsuitable for the Saké brewing. 10 (I-X) varieties.

I) *Production of Fukui prefecture.*

a) Percentage of full grown grains. ——87.2

b) Exteral appearance and luster. Straw yellow colour, grains were fat and of middle size, poor of luster. (2nd class)

c) Size of grains. (m.m.)

thickness above	2.2	58.10 g.	29 grains.
" "	2.0	31.50 "	16 "
" "	1.8	9 20 "	5 "
" under	1.8	1.20 "	—
	average.	max.	min.
length	5.24	5.70	4 50
width	2.99	3.20	2.60

d) Percentage of Shinziromai. ——3.0

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
58.17	112.45	17.30

f) Specific gravity. 1.409

h) Hardness. (kilo)

average.	max.	min.
8.30	12.08	5.25

i) Volume of 100g. — 129.0c.c.

j) Weight of 1,000 grains.—— 24.7g.

k) Volume of 1,000 grains. -17.45c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
48.29	54.45	45.00

p) Chemical composition :—

Water	11.54
Starch	72.88
Sugar	1.02
Crude protein	8.37
" fat	2.33
Ash	1.21

II) *Production of Fukui prefecture.*

a) Percentage of full grown grains.——90.4

b) External appearance and luster.——Same as I).

c) Size of grains. (m.m.)

thickness above	2.2	17.50 g.	9 grains.
" "	2.0	45.70 "	23 "
" "	1.8	34.50 "	17 "
" under	1.8	2.30 "	1 "

	average.	max.	min.
length	4.91	5.20	4.50
width	2.83	3.00	2.60

d) Percentage of Shinziromai.——0.6%

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
48.01	69.20	17.30

f) Specific gravity.——1.394

h) Hardness. (kilo)

average	max.	min.
7 96	12.11	4.56

i) Volume of 100g.——126.5c.c.

j) Weight of 1,000 grains. ——20.05g.

k) Volume of 1,000 grains.——14.1c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
44 92	48.83	38.25

p) Chemical composition :—

Water	11.78
Starch	74.23
Sugar	0.77
Crude protein	9.25
" fat	2.29
Ash	1.23

III) *Production of Saga prefecture.*

a) Percentage of full grown grains.——87.5

b) External appearance and luster.——Same as I).

c) Size of grains. (m.m.)

thickness above	2.2	47.85 g.	24 grains.
" "	2.0	36.50 "	18 "
" "	1.8	13.70 "	7 "
" under	1.8	1.60 "	1 "

	average.	max.	min.
length	5.24	5.75	4.75
width	3.01	3.25	2.75

d) Percentage of Shinziromai.——0.8

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
44.68	61.10	17.30

f) Specific gravity.——1.389

h) Hardness. (kilo)

average	max.	min.
5.42	7.16	3.56

i) Volume of 100g.——131.5c.c.

j) Weight of 1,000 grains.——24.40g.

k) Volume of 1,000 grains.——17.50c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
48.50	51.30	45.23

p) Chemical composition :—

Water	13.90
Starch	73.11
Sugar	0.77
Crude protein	9.40
" fat	0.70
Ash	1.21

IV) *Production of Hiroshima prefecture.*

a) Percentage of full grown grains.——79.4

b) External appearance and luster.——Nearly same as III).

c) Size of grains. (m.m.)

thickness above	2.2	52.65 g.	27 grains.
" "	2 0	30.60 "	15 "
" "	1.8	12.60 "	6 "
" under	1.8	3 60 "	2 "
	average	max.	min.
length	5.15	5.70	4.60
width	3.01	3.39	2.60

d) Percentage of Shinziromai.——3.6

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
57.52	95.15	25.95

f) Specific gravity. 1.409

h) Hardness. (kilo)

average.	max.	min.
4.96	7.28	3.15

i) Volume of 100g.——129.0c.c.

j) Weight of 1,000 grains.——24.4g.

k) Volume of 1,000 grains.——17.3c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
45.82	49.50	39.83

p) Chemical composition :—

Water	13.20
Starch	74.23
Sugar	0.77
Crude protein	8.23
〃 fat	2.09
Ash	1.23

V) *Production of Yamaguchi prefecture.*

a) Percentage of full grown grains.——87.2

b) External appearance and luster.——Nearly same as 1), but luster was better than I.

c) Size of grains. (m.m.)

thickness above	2.2	50 65 g.	25 grains.
〃 〃	2.0	35.65 〃	18 〃
〃 〃	1.8	11.80 〃	6 〃
〃 under	1.8	1.85 〃	1 〃
	average.	max.	min.
length	5.17	5.50	4.85
width	3.03	3 20	2.85

d) Percentage of Shinziromai.——3.0 %

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
43.03	69.20	17.30

f) Specific gravity.——1.429

h) Hardness. (kilo)

average.	max	min.
6.10	9.15	3.94

i) Volume of 100g.——124.0c.c.

j) Weight of 1,000 grains.——24.7g.

k) Volume of 1,000 grains. ——17.5c.c.

m) Thickness of bran layer. (ρ)

average.	max.	min.
47.41	51.30	43.43

p) Chemical composition :—

Water	12.82
Starch	69.78
Sugar	0.71
Crude protein	9.40
〃 fat	2.31
Ash	1.25

VI) *Production of Niigata prefecture.*

a) Percentage of full grown grains.——93.3

b) External appearance and luster.——Nearly same as 1).

c) Size of grains. (m.m.)

thickness above		2.2	79.70 g.	40 grains.
〃	〃	2.0	15.15 〃	8 〃
〃	〃	1.8	4.45 〃	2 〃
〃	under	1.8	0.60	—
		average.	max.	min.
	length	4.77	5.30	4.25
	width	3.03	3.30	2.80

d) Percentage of Shinziromai.——0.7

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
50.82	95.15	17.30

f) Specific gravity.——1.385

h) Hardness. (kilo)

average.	max.	min.
4 91	6.79	2.70

i) Volume of 100g.——129.0c.c.

j) Weight of 1,000 grains.——23.40g.

k) Volume of 1,000 grains. 16.65c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
49.91	54.00	46.58

p) Chemical composition :—

Water	14.01
Starch	71.87
Sugar	0.90
Crude protein	8.23
〃 fat	1.03
Ash	1.16

VII) *Production of Miye prefecture.*

a) Percentage of full grown grains.——94.4

b) External appearance and luster.——Nearly same as V).

c) Size of grains. (m.m.)

thickness above		2.2	19.90 g.	10 grains.
〃	〃	2.0	54.50 〃	27 〃
〃	〃	1.8	23.00 〃	12 〃
〃	under	1.8	2.50 〃	1 〃
		average.	max.	min.
	length	4.94	5.80	4.65
	width	2.98	3.20	2.55

d) Percentage of Shinziromai.——1.1

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
51.04	86.50	17.50

f) Specific gravity.——1.389

h) Hardness. (kilo)

average.	max.	min.
5.61	8.33	3.28

i) Volume of 100g.——125.5c.c.

j) Weight of 1,000 grains.——21.30g.

k) Volume of 1,000 grains.——14.90c.c.

m) Thickness of bran layer. (μ)

average.	max	min.
45.17	55 13	38.70

p) Chemical composition :—

Water	12.53
Starch	72 29
Sugar	0 32
Crude protein	7.93
" fat	2.14
Ash	1 36

VIII) *Production of Kochi prefecture.*

a) Percentage of full grown grains.——81.2

b) External appearance and luster.——Nearly same as I).

c) Size of grains. (m.m.)

thickness above	2 2	30.10 g	15 grains
" "	2 0	42 10 "	21 "
" "	1 8	22 30 "	11 "
" under	1.8	5 30	3 "
	average.	max.	min
length	5.24	5.75	4 80
width	2 93	3.10	2.60

d) Percentage of Shinziromai.——1.0

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
60.77	103 80	17.30

f) Specific gravity.——1.399%.

h) Hardness. (kilo)

average.	max	min.
8.32	12.45	5.01

i) Volume of 100g.——126.0c.c.

j) Weight of 1,000 grains.——23.10g.

k) Volume of 1,000 grains.——16.30c.c.

m) Thickness of bran layer. (μ)

average.	max	min.
49.50	56.25	43.88

p) Chemical composition :—

Water	12.70
Starch	69.97
Sugar	1.15
Crude protein	8.52
" fat	2 50
Ash	1.39

IX) *Production of Tokushima prefecture.*

a) Percentage of full grown grains.——56.8

b) External appearance and luster.——Straw brawn colour, destitute of luster, impurities were abundant. (2nd class).

c) Size of grains. (m.m.)

thickness above	2.2	41.20 g.	21 grains.
" "	2.0	30.00 "	15 "
" "	1.8	20.80 "	10 "
" under	1.8	7.80 "	4 "
	average.	max.	min.
length	4.75	5.65	4.10
width	2.93	3 15	2.50

d) Percentage of Shinziromai.——0.2

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
49.26	112.45	17.30

f) Specific gravity.——1.370

h) Hardness. (kilo)

average.	max.	min.
5.31	7.69	3 19

i) Volume of 100g.——127.0c.c.

j) Weight of 1,000 grains.——21.1g.

k) Volume of 1,000 grains.——15.0c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
47 82	53.55	45.00

p) Chemical composition :—

Water	13.80
Starch	74.63
Sugar	1.53
Crude protein	8 52
" fat	2.16
Ash	1.23

X) *Production of Aomori prefecture.*

a) Percentage of full grown grains.——24.7

b) External appearance and luster.——Grey brown colour, no luster, impurities were abundant. (3rd class).

c) Size of grains. (m.m.)

thickness above	2.2	10.70 g.	5 grains.
〃 〃	2.0	17.60 〃	8 〃
〃 〃	1.8	25.20 〃	13 〃
〃 〃	1.8	46.20 〃	24 〃
	average.	max.	min.
length	4.81	5.65	4.25
width	2.75	3.15	2.25

d) Percentage of Shinziromai.——0.3

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
59.90	95.15	25 95

f) Specific gravity.——

h) Hardness. (kilo)

average.	max.	min.
4.38	8.16	2.44

i) Volume of 100g.——148.5c.c.

j) Weight of 1,000 grains.——

k) Volume of 1,000 grains.——

m) Thickness of bran layer. (μ)

average.	max.	min.
51.08	55.13	46.80

p) Chemical composition :—

Water	15.18
Starch	70.34
Sugar	1.35
Crude protein	8.81
〃 fat	1.87
Ash	1 15

β') Polished rice, unsuitable for the Saké brewing. 11 (I–XI) varieties.

I) *Production of Fukui prefecture.*

b) External appearance and luster.— 2nd class.

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
39.57	77.85	0

h) Hardness. (kilo)

average.	max.	min.
5.05	7.01	3.19

p) Chemical composition :—

Water	13.37
Starch	72.08
Sugar	0.66

Crude protein	8.54
" fat	0.46
Ash	0.45

II) *Production of Fukui prefecture.*

b) External appearance and luster.—— Same as I).

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
37.63	60.55	17.30

h) Hardness. (kilo)

average.	max.	min.
6.61	9.41	4 35

p) Chemical composition :—

Water	14.10
Starch	75.68
Sugar	0.41
Crude protein	8.54
" fat	0.51
Ash	0.46

III) *Production of Saga prefecture.*

b) External appearance and luster.— Nearly same as I).

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
36.33	69.20	0

h) Hardness. (kilo)

average.	max.	min.
4.38	8.16	2.44

p) Chemical composition :—

Water	15.26
Starch	72.91
Sugar	0.71
Crude protein	7.32
" fat	0.20
Ash	0.42

IV) *Production of Hiroshima prefecture.*

b) External appearance and luster.——Same as I).

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
35.25	69.20	17.30

h) Hardness. (kilo)

average.	max.	min.
4.54	7.78	3.02

p) Chemical composition :—

Water	14.35
Starch	74.55
Sugar	1.62
Crude protein	8.81
" fat	0.57
Ash	0.41

V) *Production of Yamaguchi prefecture.*

b) Extereal appearance and luster.——Nearly same as IV).

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
43 03	69.20	17 30

h) Hardness. (kilo)

average.	max.	min.
6.49	11.44	3.68

p) Chemical composition :—

Water	14.30
Starch	76.01
Sugar	1.42
Crude protein	8.54
" fat	0.48
Ash	0 56

VI) *Production of Niigata prefecture.*

b) External appearance and luster.— Nearly same as I).

e) Depth of longitudinal furrow. (μ)

average	max.	min
43.68	77.85	17.30

h) Hardness. (kilo)

average	max	min.
3 08	4 56	1 88

p) Chemical composition :—

Water	14.66
Starch	74.24
Sugar	0.76
Crude protein	9.47
" fat	0.25
Ash	0.38

VII) *Production of Miye prefecture.*

b) External appearance and luster. —Nearly same as V).

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
38.91	51.90	0

h) Hardness. (kilo)

average.	max	min.
2.85	4 74	1.88

p) Chemical composition :—

Water	14.90
Starch	72.04
Sugar	0.71
Crude protein	8.18
〃 fat	0.10
Ash	0.45

VIII) *Production of Kochi prefecture.*

b) External appearance and luster.—— Somewhat worse than I).

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
40 44	69.20	17.30

h) Hardness. (kilo)

average.	max.	min.
6.61	9 41	4.35

i) Chemical composition :—

Water	14.60
Starch	73.45
Sugar	1.65
Crude protein	7.49
〃 fat	0.85
Ash	0.38

IX) *Production of Tokushima prefecture.*

b) External appearance and luster. – -Nearly same as I).

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
39.79	69.20	17.30

h) Hardness. (kilo)

average	max.	min.
3 37	5.93	2.12

p) Chemical composition :—

Water	14.70
Starch	72.99
Sugar	0 90
Crude protein	8.15
〃 fat	0.57
Ash	0.99

X) *Production of Aomori prefecture.*

b) External appearance and luster.——Nearly same as VIII)

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
50.82	86 50	17.30

h) Hardness. (kilo)

TABLE XI. 1919 Husked rice.

(Suitable for the Saké brewing.)

	External appearance and lustre	% of full grown grains.	% of Shinziromai	Depth of longitudinal furrow. (μ)	Volume of 100 g (c c.)	Specific gravity	Weight of 1,000 grains (g.)	Volume of 1,000 grains. (c c.)	Hardness. (kilo)	Thickness of bran layer. (μ)	Water	Starch	Sugar	Crude protein	Crude fat	Ash
A	1st Class	90.0	13.3	57.5	121.0	1.42	26.9	19.0	6.07	33 3	12.46	72.03	0.71	8.52	2.24	1.28
B	"	98.6	91.6	57.3	125.5	1.40	27.1	19.4	4.80	42.2	14.23	74.12	0.90	10.13	1.72	1.03
C	"	98.3	92.6	59.6	121.0	1.40	26.4	18.7	5.63	44.3	11.95	70.08	1.53	9.69	1.94	1.19
D	"	97.0	80.7	53.8	124.0	1.41	27.3	19.3	4 64	53 8	12 82	73.05	0.83	9.25	1.51	0.95
E	"	93.4	5.8	59.2	125.0	1.41	24.5	17.2	6.12	41.3	12.94	72.09	0.65	9.11	2.40	1.29
F	"	96.5	4.6	54 7	122 0	1.40	24.8	17.7	6 17	39.9	13.87	74.28	0.71	8.82	1.96	1.23
G	"	93 3	47.1	49.3	124.0	1.40	25.6	18.1	5.22	42.3	12 80	71.98	0.77	9.69	2.18	1.21
H	"	83.7	1.5	53.2	124.0	1.38	24.2	17.1	5.83	43.3	12.86	70.74	0 90	7.34	2.10	1.21
I	"	92.8	9.5	47.8	120 5	1.40	26.6	18 8	6.50	42.5	12.94	72.99	0.90	9.10	2.06	1.04
J	2nd Class	95.3	0 6	44.3	129.0	1.39	22.4	16.0	5.55	44.3	13.89	70.43	0.65	8.81	2.00	1.08
K	"	93.5	3.2	47 6	121.0	1.41	24.2	17.1	6.25	42.3	12.94	71.40	1.53	9.69	2.30	1.34
L	1st Class	95.3	19.3	45.4	121 0	1.40	26.2	18.5	5.22	45.4	12.55	73.51	0.32	8.52	2.17	1.06
M	"	96.9	21.8	48.2	120.0	1.41	27.1	19.4	5 34	42.1	12.70	71.43	1.53	9.11	2.25	1.08
N	"	96.5	20.2	38.5	123.0	1.41	27.8	19.8	5.98	38.5	12.67	72.88	1.02	8.22	2.33	1.08
O	"	96.7	26 3	52 9	120.5	1.42	25 4	17.8	5.80	44.0	12.06	72.77	1.15	7.64	2.18	1.16
P	2nd Class	96.5	3.6	50.2	130.5	1.39	25.4	18.1	3 61	42.7	15.20	73.11	0.77	8.59	2.09	1.24
Q	"	94.4	6 6	55.1	133.0	1.39	23.7	16.9	3.88	41.6	14 89	73 55	1.53	7.05	0.73	0.90
R	"	96.2	1.8	47.8	132.0	1.39	23.2	16.4	4 03	43.3	14.73	72.59	1.14	8.37	1.01	1.71
S	"	90.2	1.8	43.9	131.5	1.39	23.7	17.0	4.26	44.3	15 19	73 51	0.32	8.15	0.60	1.22

TABLE XII. 1919 Husked rice.

(Unsuitable for the Saké brewing.)

	External appearance and luster	% of full grown grains.	% of Shinzironai	Depth of longitudinal furrow. (μ)	Volume of 100g (c c)	Specific gravity	Weight of 1,000 grains (g.)	Volume of 1,000 grains (c c)	Hardness (kilo)	Thickness of bran layer (μ)	Water	Starch	Sugar	Crude protein	Crude fat	Ash
I	2nd Class	87.2	3.0	58.2	129.0	1.41	24.7	17.5	8 30	48.3	11.54	72 88	1.02	8.37	2.33	1.20
II	〃	90.4	0.6	48.0	126.5	1.39	20.1	14 1	7.96	44.9	11 78	74.23	0.77	9.25	2.29	1.23
III	〃	87.5	0.8	44.7	131 5	1.39	24.4	17.5	5.42	48 5	13 90	73.02	0.77	9.40	0.70	1.21
IV	〃	79.4	3 0	57.5	129.0	1.41	24.4	17.3	4.97	45.8	13.20	74 23	0.77	8 23	2.08	1.23
V	1st Class	87.2	3 0	43 0	124.0	1.38	24.7	17 5	6.10	47.4	12 82	69.78	0 71	9.40	2.31	1.25
VI	2nd Class	93 3	0 7	50.8	129.0	1.38	23.4	16.7	4.91	49.9	14 01	71.87	0.90	8.23	1.03	1.16
VII	1st Class	94.4	1.1	51.0	125.5	1.39	21 3	14.9	5 61	45.1	12.53	72 30	0.82	7 93	2.14	1.40
VIII	2nd Class	81.2	1.0	60.8	126.0	1.40	23.1	16.3	8.32	49.5	12.70	69.97	1 15	8.52	2.50	1.39
IX	3rd Class	56.8	0 2	49.3	127.0	1.37	21.1	15 0	5.31	47.8	13.80	74.63	1.53	8.52	2.16	1.23
X	〃	24.7	0.3	59.9	148.5	—	—	—	4.38	51.1	15.18	70.34	1.35	8 81	1.87	1.15

TABLE XIII. 1919 Polished rich.
(Suitable for the Saké brewing.)

	External appearance and luster	Depth of longitudinal furrow. (μ)	Hardness (kilo)	Water	Starch	Crude protein	Crude fat	Ash
A	1st Class	33.3	4 17	13.90	76.37	7.49	0.43	0.39
B	〃	38.3	4.02	14.90	73.43	8.54	0.24	0.29
C	〃	40.3	4.06	13.70	77.53	8.18	0.13	0.30
D	〃	31.6	4.89	14.70	74.56	8.18	0.21	0.35
E	〃	32.7	3.92	14.18	72.85	9.25	0.22	0.42
F	〃	33.3	3.15	15.30	74.95	7.32	0.20	0.42
G	〃	34.9	4.13	15.40	75.20	9.25	0 20	0.36
H	〃	30.3	4.60	15.10	74.97	9.47	0.36	0.42
I	〃	33.5	4.53	15.00	76.60	8.37	0.29	0 66
J	2nd Class	30.3	4.89	15.20	76.10	8.54	0.21	0.34
K	〃	23.8	4.25	14.50	73.95	7.32	0.19	0.52
L	1st Class	15.6	4.40	15.30	74.04	8.18	0.13	0.57
M	〃	33.2	4.09	14.90	75.47	7.02	0.24	0.33
N	〃	24.9	4.70	13.50	77.50	7.93	0.31	0.34
O	〃	38.5	4.46	13.60	73.62	7.49	0.59	0.43
P	〃	38.1	2.71	15.13	75.73	9.04	0.18	0.31
Q	2nd Class	45.8	3.09	14.80	74.60	9.04	0.14	0.28
R	〃	38.1	3.12	15.60	73.94	9.47	0.48	0.28
S	〃	25.7	3.31	14.57	73.43	9.04	0.27	0.30

TABLE XIIII. 1919 Polished rice.
(Unsuitable for the Saké brewing.)

	External appearance and luster	Depth of longitudinal furrow. (μ)	Hardness (kilo)	Water	Starch	Crude protein	Crude fat	Ash
I	2nd Class	39.6	5.05	13 37	72.08	8.54	0.46	0.45
II	〃	37.6	6.61	14.10	75.68	8.54	0.51	0.46
III	〃	36.3	4.38	15.26	72.91	7.32	0.20	0.42
VI	〃	35.2	4.54	14.35	74.55	8.81	0 57	0.41
V	〃	43.0	6.49	14.30	76.01	8.54	0.48	0.56
VI	〃	43.7	3.88	14.66	74.24	9.48	0.25	0.38
VII	1st Class	33.9	2.85	14.90	72.04	8.18	0.10	0.45
VIII	3rd Class	40.4	6.61	14.60	73.45	7.49	0.85	0.38
IX	2nd Class	39.8	3.37	14.70	73.00	8.15	0.57	0.99
X	3rd Class	50.8	3.86	14.80	74.12	7.53	0.69	0.88
XI	〃	—	4.61	13.20	76.89	7.93	0.65	0.59

average.	max.	min.
3.86	7.31	2.34

p) Chemical composition :—

Water	14.80
Starch	74.12
Sugar	0.90
Crude protein	7·53
" fat	0 69
Ash	0.88

XI) *Saigon rice.*

b) External appearance and luster. - -Nearly same as X), but grains were slender than the former, impurities were abundant.

h) Hardness. (kilo)

average.	max.	min.
4.61	6.38	3 19

p) Chemical composition :—

Water	13.20
Starch	76.88
Sugar	0.32
Crude protein	7 93
" fat	0 65
Ash	0.59

Summary of the 1919 production.

The suitable materials showed high luster and fine external appearance compared with the unsuitable. Percentage of full grown grains, shinziromai, size of grains, specific gravity, both weight and volume of 1,000 grains, and the contents of water, carbohydrates and crude protein were found to be greater in the suitable materials, while depth of longitudinal furrow, volume of 100g., hardness, thickness of bran layer, crude fat and ash were found to be smaller.

1921 Production.

a) Husked rice, suitable for the Saké brewing. 23 (A–W) varieties.

A) *Production of Okayama prefecture.*

a) Percentage of full grown grains.——91.4

b) External appearance and luster.——Straw yellow waxy luster, grains were fat and large. (1st class).

c) Size of grains. (m.m.)

thickness above	2.2	69.5 g.	35 grains.
" "	2.0	25.1 "	13 "
" "	1.8	4.7 "	2 "
" under	1.8	0.7 "	—

	average.	max.	min.
length	5.42	5.85	4.85
width	3.06	3.25	2.90

d) Percentage of Shinziromai.——13.0

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
44.33	60.55	17.30

f) Specific gravity.——1.418

h) Hardness. (kilo)

average.	max.	min.
5.73	8.18	3.49

i) Volume of 100g.——124.5c.c.

j) Weight of 1,000 grains.——25.75g.

k) Volume of 1,000 grains. - 18.4c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
41.41	44.33	37.00

p) Chemical composition :—

Water	13.64
Starch	74.37
Sugar	1.99
Crude protein	8 39
" fat	1.66
Ash	1.22

B) *Production of Niigata prefecture.*

a) Percentage of full grown grains.——90.6

b) External appearance and luster.—— Nearly same as A).

c) Size of grains. (m.m.)

thickness	above	2.2	64.7 g.	32 grains.
"	"	2.0	26.6 "	13 "
"	"	1.8	7.5 "	4 "
"	under	1.8	1.0	1

	average.	max.	min.
length	5.34	5.70	4.90
width	3.07	3 30	2 75

d) Percentage of Shinziromai. 1.6

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
48.87	69.20	25.95

f) Specific gravity.——1.389

h) Hardness. (kilo)

average.	max.	min.
4 36	5.48	3.04

i) Volume of 100g.——130.0c.c.
j) Weight of 1,000 grains.—— 24.6g.
k) Volume of 1,000 grains.——17.6c.c.
m) Thickness of bran layer. (μ)

average.	max.	min.
44.49	50.40	38.93

p) Chemical composition :—

Water	14.72
Starch	74.05
Sugar	1.10
Crude protein	8.82
〃 fat	0.98
Ash	1.28

C) *Production of Osaka prefecture.*

a) Percentage of full grown grains.——89.4
b) External appearance and luster.——Same as A).
c) Size of grains. (m.m.)

thickness above	2.2	56.0 g.	28 grains.
〃 〃	2.0	33.0 〃	17 〃
〃 〃	1.8	9.7 〃	5 〃
〃 under	1.8	1.2 〃	—
	average.	max.	min.
length	5.42	5.75	5.00
width	3.08	3.40	2.95

d) Percentage of Shinziromai.——17.6
e) Depth of longitudinal furrow. (μ)

average.	max.	min.
56.01	77.85	25.95

f) Specific gravity.——1.399
h) Hardness. (kilo)

average.	max.	min.
5.15	7.88	3.00

i) Volume of 100g.——125.0c.c.
j) Weight of 1,000 grains.——25.2g.
k) Volume of 1,000 grains.——17.9c.c.
m) Thickness of bran layer. (μ)

average.	max.	min.
41.51	44.78	37.13

p) Chemical composition :—

Water	14.40
Starch	75.48
Sugar	0.76
Crude protein	8.54
〃 fat	1.75
Ash	1.17

D) *Production of Hyogo prefecture.*

a) Percentage of full grown grains.——89.1

b) External appearance and luster.—— Same as C).

c) Size of grains. (m.m.)

thickness	above	2.2	54.8 g.	27 grains
〃	〃	2.0	34.9 〃	18 〃
〃	〃	1.8	9 4 〃	5 〃
〃	under	1.8	0.9 〃	—

	average.	max.	min.
length	5.55	5.85	5.15
width	3.17	3.40	2.95

d) Percentage of Shinziromai.——80.2%

e) Depth of longitudinal furrow. (μ)

average.	max.	mim.
60.98	86.50	25.95

f) Specific gravity.——1.409

h) Hardness. (kilo)

average.	max.	min.
5.59	8.61	3.19

i) Volume of 100g.——123.0c.c.

j) Weight of 1,000 grains.——26.2g.

k) Volume of 1,000 grains. —18.55c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
41.05	47.48	33.75

p) Chemical composition :—

Water	13.40
Starch	75.35
Sugar	0.90
Crude protein	9.90
〃 fat	1.84
Ash	1.24

E) *Production of Hyogo prefecture.*

a) Percentage of full grown grains. —95.1

b) External appearance and luster.——Same as C).

c) Size of grains. (m.m.)

thickness	above	2.2	55.90 g.	28 grains.
〃	〃	2.0	36.40 〃	18 〃
〃	〃	1.8	7.20 〃	4 〃
〃	under	1.8	0.50 〃	—

	average.	max.	min.
length	5.47	5.85	5.10
width	3.19	3.40	3.00

d) Percentage of Shinziromai.——79.8

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
56.01	86.50	25.95

f) Specific gravity.——1.413

h) Hardness. (kilo)

average.	max.	min.
5.29	9.38	3.65

i) Volume of 100g.——121.0c.c.

j) Weight of 1,000 grains.——25.5g.

k) Volume of 1,000 grains. —18.1c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
41.81	46.58	37.58

p) Chemical composition :—

Water	12 80
Starch	73.19
Sugar	1.35
Crude protein	7.53
" fat	2.07
Ash	1.28

F) *Production of Hyogo prefecture.*

a) Percentage of full grown grains.- - 93.1

b) External appearance and luster. —Same as C).

c) Size of grains. (m.m.)

thickness above	2.2	58.30 g.	29 grains
" "	2.0	32.90 "	17 "
" "	1.8	8.20 "	4 "
" under	1.8	0.50 "	—

	average.	max.	min.
length	5.46	5.80	5.00
width	3.17	3.30	2.85

d) Percentage of Shinziromai.---—72.6

f) Specific gravity.——1.413

h) Hardness. (kilo)

average.	max.	min.
5.00	7.41	2.85

i) Volume of 100g.——124.0c.c.

j) Weight of 1,000 grains.——25.9g.

k) Volume of 1,000 grains. 18.4c.c.

p) Chemical composition :—

Water	14.50
Starch	75.60

Sugar	1.25
Crude protein	9.47
" fat	1.35
Ash	1.24

G) *Production of Okayama prefecture.*

a) Percentage of full grown grains.— 92.9

b) External appearance and luster. —Same as B).

c) Size of grains. (m.m.)

thickness above	2 2	82.70 g.	41 grains
" "	2 0	12.40 "	6 "
" "	1.8	3.80 "	2 "
" under	1.8	0.90 "	1 "

	average.	max.	min.
length	5.46	5.80	5 20
width	3 12	3 35	2 95

d) Percentage of Shinziromai. 79.9

e) Depth of longitudinal furrow. (μ)

average	max	min
51.91	86 50	25 95

f) Shecific gravity. 1.399

h) Hardness. (kilo)

average	max.	min
5 13	7 13	3.86

i) Volume of 100g. - 124.5c.c.

j) Weight of 1,000 grains. 27.2g.

k) Volume of 1,000 grains. 19.4c.c.

m) Thickness of bran layer. (μ)

average.	max.	min
42 00	45 68	38.25

p) Chemical composition :—

Water	14.40
Starch	75.65
Sugar	1.20
Crude protein	8.82
" fat	2.14
Ash	1.10

H) *Production of Okayama prefecture*

a) Percentage of full grown grains.— -98.9

b) External appearance and luster.——Same as G).

c) Size of grains. (m.m.)

thickness above	2.2	36.7 g.	18 grains.
" "	2.0	41.5 "	21 "
" "	1.8	19.1 "	10 "
" under	1.8	2.7 "	1 "

	average.	max.	min.
length	5.40	5.95	5.00
width	3.08	3.30	2.90

d) Percentage of Shinziromai. —24.0

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
59.04	86.50	43.25

f) Specific gravity. — 1.409

h) Hardness. (kilo)

average.	max.	min.
5.72	8.55	4.24

i) Volume of 100g. 127.5c.c.

j Weight of 1,000 grains.—— 24.60g.

k) Volume of 1,000 grains. 17.45c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
41.45	44.78	38.03

p) Cnemical composition :—

Water	13.00
Starch	72 95
Sugar	1.70
Crude protein	7.75
〃 fat	1.87
Ash	1.34

I) *Production of Okayama Prefecture.*

a) Percentage of full grown grains.——92.7

b) External appearance and luster Same as H).

c) Size of grains. (m.m.)

thickness above	2.2	61.0 g.	31 grains
〃 〃	2.0	31.0 〃	16 〃
〃 〃	1.8	7.4 〃	3 〃
〃 under	1.8	0.6 〃	—

	average.	max.	min.
length	5.45	5.80	5.15
width	3.07	3.25	2.85

d) Percentage of Shinziromai.——72.8

e) Depth of longitudinal furrow (μ)

average.	max.	min.
51.68	86.50	34.60

f) Specific gravity.——1.404

h) Hardness (kilo)

average.	max.	min.
6.16	9.49	3.86

i) Volume of 100g. ——123.0c.c.

j) Weight of 1,000 grains.——25.85g.

k) Volume of 1,000 grains.—— 18.4c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
43.55	47.25	38.70

p) Chemical composition :—

Water	12.60
Starch	75.35
Sugar	0.90
Crude protein	9.04
" fat	2.43
Ash	1.27

J) *Production of Hiroshima prefecture.*

a) Percentage of full grown grains.— 94.8

b) External appearance and luster. Same as I).

c) Size of grains. (m.m.)

Thickness above	2.2	88.3 g.	42 grains.
" "	2.0	13.7 "	7 "
" "	1.8	2.7 "	1 "
" under	1.8	0.7 "	—

	average.	max.	min.
length	5.38	5.70	5.00
width	3.12	3.25	2.95

d) Percentage of Shinziromai. —66.0

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
50.60	69.20	34.60

f) Specific gravity. 1.409

h) Hardness. (kilo)

average.	max.	min.
5.46	9.75	3.56

i) Volume of 100g. — 125.0c.c.

j) Weight of 1,000 grains.— 26.90g.

k) Volume of 1,000 grains.— —19.10c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
41.45	44.78	38.03

p) Chemical composition :—

Water	12.80
Starch	74.90
Sugar	1.40
Crude protein	9.47
" fat	1.99
Ash	1.17

K) *Production of Okayama prefecture.*

a) Percentage of full grown grains.— 90.5

b) External appearance and luster.— Same as J).

c) Size of grains. (m.m.)

Thickness	above	2.2	72.5 g.	36 grains.
〃	〃	2.0	21.7 〃	11 〃
〃	〃	1.8	5.3 〃	3 〃
〃	under	1.8	0.4 〃	—

	average.	max.	min.
length	5.41	5.80	4.80
width	3.08	3.25	2.90

d) Percentage of Shinziromai. ---14.8

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
53.41	86.50	34.60

f) Specific gravity.— 1.404

h) Hardness. (kilo)

average.	max.	min.
5.55	9.00	3.64

i) Volume of 100g. —126.0c.c.

j) Weight of 1,000 grains. —26.45g.

k) Volume of 1,000 grains. -18.8c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
41.03	44.78	37.58

p) Chemical composition :—

Water	13.80
Starch	74.14
Sugar	1.00
Crude protein	9.90
〃 fat	1.68
Ash	1.14

L) *Production of Okayama prefecture.*

a) Perentage of full grown grains.— 93.2

b) External appearance and luster.— Same as J).

c) Size of grains. (m.m.)

thickness	above	2.2	30.0 g.	15 grains.
〃	〃	2.0	54.0 〃	27 〃
〃	〃	1.8	15.2 〃	8 〃
〃	under	1.8	0.8 〃	— 〃

	average.	max.	min.
length	5.26	5.65	4.85
width	3.03	3.20	2.85

d) Percentage of Shinziromai.——3.4

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
53.85	86.50	17.30

f) Specific gravity.——1.418

h) Hardness. (kilo)

average.	max.	min.
5.62	8.00	3.66

i) Volume of 100g.——125.0c.c.

j) Weight of 1,000 grains.—— 23.9g.

k) Volume of 1,000 grains.——16.9c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
41.98	47.70	38.25

p) Chemical composition :—

Water	13.00
Starch	73.18
Sugar	0.81
Crude protein	9.47
" fat	2.01
Ash	1.31

M) *Production of Okayama prefecture.*

a) Percentage of full grown grains. - 97.5

b) External appearance and luster. - Same as B).

c) Size of grains. (m.m.)

thickness above		2.2	63.8 g.	32 grains.
"	"	2.0	29.9 "	15 "
"	"	1.8	5.8 "	3 "
"	under	1.8	0.4 "	—

	average	max.	min.
length	5.48	5.80	5.0
width	3.13	3 35	3.0

d) Percentage of Shinziromai. —— 83.0

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
54.49	86.50	17.30

f) Specific gravity.——1.409

h) Hardness. (kilo)

average.	max.	min.
5.47	7.22	2.93

i) Volume of 100g.——122.0c.c.

j) Weight of 1,000 grains.——25.7g.

k) Volume of 1,000 grains.——18.35c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
41.28	44.78	36.68

p) Chemical composition :—

Water	14.40
Starch	73.79
Sugar	0.76
Crude protein	9 90
" fat	1.90
Ash	1 22

N) *Production of Okayama prefecture.*

a) Percentage of full grown grains. 88.85

b) External appearance and luster. –Same as M).

c) Size of grains. (m.m.)

thickness above	2 2	85.0 g	43 grains.
" "	2 0	12.1 "	6 "
" "	1 8	2 5 "	1 "
" under	1 8	0.3 "	—

	average	max.	min.
length	5.51	5.90	5.15
width	3.19	3 40	3 00

d) Percentage of Shinziromai.— 25.2

e) Depth of longitudinal furrow. (μ)

average	max.	min.
49.52	69 20	34 60

f) Specific gravity. –1.404

h) Hardness. (kilo)

average	max.	min.
4.43	7 14	3 00

i) Volume of 100g.— –126.0c.c.

j) Weight of 1,000 grains.— 27.7g.

k) Volume of 1,000 grains. – 19.75c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
41.70	46 80	38 70

p) Chemical composition :—

Water	14.07
Starch	72.79
Sugar	1.70
Crude protein	9.90
" fat	1.52
Ash	1.13

O) *Production of Kumamoto prefecture.*

a) Percentage of full grown grains.——91.4

b) External appearance and luster. ——Nearly same as B).

c) Size of grains. (m.m.)

thickness above	2.2	51.2 g.	26 grains.
〃 〃	2.0	40.2 〃	20 〃
〃 〃	1.8	7.8 〃	4 〃
〃 under	1.8	0.8 〃	—

	average.	max.	min.
length	5.07	5.75	4.75
width	2.98	3.20	2.65

d) Percentage of Shinziromai.——1.4

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
58.39	103.80	34.60

f) Specific gravity.— 1.394

h) Hardness. (kilo)

average.	max.	min.
5.13	7.54	3.49

i) Volume of 100g. 129.0c.c.

j) Weight of 1,000 grains.——24.13g.

k) Volume of 1,000 grains. 17.20c.c.

m) Thickness of bran layer. (μ)

average	max	min.
42 99	47.70	39 83

p) Chemical composition :—

Water	15 20
Starch	75.31
Sugar	0.95
Crude protein	9 47
〃 fat	1 74
Ash	1 22

P) *Production of Kumamoto prefecture.*

a) Percentage of full grown grains.——82.2

b) External appearance and luster.—— Same as M).

c) Size of grains. (m.m.)

thickness above	2 2	54.7 g.	27 grains.
〃 〃	2.0	34.4 〃	17 〃
〃 〃	1 8	9.6 〃	5 〃
〃 under	1.8	1.2 〃	1 〃

	average.	max	min.
length	5.18	5.65	4.75
width	3.07	3 30	2.70

d) Percentage of Shinziromai.—— 9.1

e) Depth of longitudinal furrow. (μ)

average.	max.	min
56.87	77.75	36.60

f) Specific gravity.— 1.409

h) Hardness. (kilo)

average.	max	min.
5.71	9 23	3.84

i) Volume of 100g.— -126.0c.c.

j) Weight of 1,000 grains. —24.3g.

k) Volume of 1,000 grains.- —17.3c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
42.58	45.68	37.35

p) Chemical composition :—

Water	13.60
Starch	72.47
Sugar	1.60
Crude protein	8.18
" fat	1.39
Ash	1.23

Q) *Production of Kumamoto prefecture.*

a) Percentage of full grown grains. 91.3

b) External appearance and luster. - Same as A).

c) Size of grains. (m.m.)

thickness above	2.2	57.6 g	29 grains.
" "	2.0	31.1 "	16 "
" "	1.8	9.6 "	5 "
" under	1.8	1.6 "	—

	average.	max.	min.
length	5.16	5.45	4.80
width	3.07	3.25	2.85

d) Percentage of Shinziromai. - 4.0

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
53.85	77.75	25.95

f) Specific gravity. – -1.399

h) Hardness. (kilo)

average.	max.	min.
5.49	7.88	3.41

i) Volume of 100g. -—126.0c.c.

j) Weight of 1,000 grains.— 24.2g.

k) Volume of 1,000 grains.— 17.3c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
42.13	45.23	39.15

p) Chemical composition :—

Water	15.03
Sterch	73.80
Sugar	1.25
Crude protein	9.04
〃 fat	1.54
Ash	1.08

R) *Production of Kumamoto prefecture.*

a) Percentage of full grown grains.– 91.4

b) External appearance and luster. Same as A).

c) Size of grains (m.m.)

thickness above	2.2	60.6 g.	30 grains.
〃 〃	2 0	30.4 〃	15 〃
〃 〃	1 8	8.0 〃	4 〃
〃 under	1.8	1.0 〃	1 〃

	average	max.	min.
length	5.13	5.75	4 75
width	3.01	3.30	2 60

d) Percentage of Shinziromai. –6.6

e) Depth of longitudinal furrow. (〃)

average	max	min.
51 47	86.50	17.30

f) Specific gravity. — 1.404

h) Hardness. (kilo)

average.	max.	min.
5.73	8.63	3.26

i) Volume of 100g. ––123.0c.c.

j) Weight of 1,000 grains.–––23.75g.

k) Volume of 1,000 grains. — 16.85c.c.

m) Thickness of bran layer. (〃)

average.	max	min.
43.44	48.83	39.60

p) Chemical composition :—

Water	13.30
Starch	73.13
Sugar	1.50
Crude protein	8.54
〃 fat	1.84
Ash	1.18

S) *Production of Akita prefecture.*

a) Percentage of full grown grains. ––95.3

b) External appearance and luster.––Same as N).

c) Size of grains. (m.m.)

thickness above.		2.2	83.0 g.	42 grains.
〃	〃	2 0	14.0 〃.	7 〃
〃	〃	1.8	2.7 〃	1 〃
〃	under	1.8	0.3 〃	— 〃
		average.	max.	min.
	length	5.20	5.55	4.95
	width	3.09	3.30	3.00

d) Percentage of Shinziromai.——4.4

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
47.58	77.85	25.95

f) Specific gravity.——1.413

h) Hardness. (kilo)

average.	max.	min.
6.30	10.50	3.19

i) Volume of 100g.——126.0c.c.

j) Weight of 1,000 grains. ——25.1g.

k) Volume of 1,000 grains.——17.8c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
43.62	47.25	40.28

p) Chemical composition :—

Water	13.90
Starch	73.79
Sugar	0.76
Crude protein	9.90
〃 fat	1.90
Ash	1.22

T) *Production of Akita prefecture.*

a) Percentage of full grown grains.——97.4

b) External appearance and luster.——Same as T).

c) Size of grains. (m.m.)

thickness above		2.2	80.0 g.	40 grains
〃	〃	2.0	18.2 〃	9 〃
〃	〃	1.8	1.6 〃	1 〃
〃	under	1.8	0.1 〃	—
		average.	max.	min.
	length	5.14	5.65	4.90
	width	3.13	3.30	3 00

d) Percentage of Shinziromai.——7.6

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
53.63	86.50	25.95

f) Specific gravity.——1.399

h) Hardness. (kilo)

average.	max.	min.
4.61	7.58	2.89

i) Volume of 100g. — 125.5c.c.

j) Weight of 1,000 grains.——24.7g.

k) Volume of 1,000 grains.——17.5c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
43.24	51.08	39.83

p) Chemical composition :—

Water	14.41
Starch	74.95
Sugar	1.35
Crude protein	7.75
// fat	1.64
Ash	1.09

U) *Production of Akita prefecture.*

a) Percentage of full grown grains.——95.1

b) External appearance and luster.——Same as T.

c) Size of grains. (m.m.)

thickness above	2.2	80.2 g.	40 grains.
// //	2.0	18.2 //	9 //
// //	1.8	1.5 //	1 //
// under	1.8	0.1 //	—

	average.	max.	min.
length	5.15	5.75	4.80
width	3.17	3 40	3 00

d) Percentage of Shinziromai.——16.8

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
54 93	77.85	25.95

f) Specific gravity.——1.409

h) Hardness. (kilo)

average.	max.	min.
5.20	8.16	3.15

i) Volume of 100g.— -125.5c.c.

j) Weight of 1,000 grains.——24.95g.

k) Volume of 1,000 grains.— —17.8c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
43.93	50.40	36.00

p) Chemical composition :—

Water	14.20
Starch	76.32

Sugar	1 20
Crude protein	8.81
〃 fat	1.95
Ash	1.06

V) *Production of Akita prefecture.*

a) Percentage of full grown grains.——95.1

b) External appearance and luster. ——Same as U).

c) Size of grains. (m.m.)

thickness above	2.2	77.5 g.	39 grains.
〃 〃	2 0	17.2 〃	9 〃
〃 〃	1.8	4.3 〃	2 〃
〃 under	1.8	0 9 〃	—

	average.	max.	min.
length	5 13	5.60	4.85
width	3.15	3.40	2.95

d) Percentage of Shinziromai.——4.0

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
48.87	77 85	17.30

f) Specific gravity.——1.394

h) Hardness. (kilo)

average.	max	min.
4.73	6 81	3.08

i) Volume of 100g.——126.5c.c.

j) Weight of 1,000 grains.——24.6g.

k) Volume of 1,000 grains.——17.55c.c.

m) Thickness of bran layer. (μ)

average	max	min
42 60	48 15	38 48

p) Chemical composition :—

Water	14 94
Starch	75.48
Sugar	0.76
Crude protein	9.90
〃 fat	1.01
Ash	0.84

W) *Production of Yamagata prefecture.*

a) Percentage of full grown grains.——92.3

b) External appearance and luster.——Same as V).

c) Size of grains. (m.m.)

thickness above	2.2	37.3 g.	19 grains.
〃 〃	2 0	45.2 〃	23 〃
〃 〃	1.8	15.5 〃	8 〃
〃 under	1.8	1.9 〃	— 〃

	average.	max.	min.
length	5.04	5.35	4.60
width	3.04	3.30	2.70

d) Percentage of Shinziromai.——1.0

e) Depth of longitudinal furrow. (μ)

average.	max.	min.
57.74	86.50	34.60

f) Specific gravity.——1.418

h) Hardness. (kilo)

average.	max.	min.
6 30	7.95	3.49

i) Volume of 100g.——127.0c.c.

j) Weight of 1,000 grains.——22.0g.

k) Volume of 1,000 grains.——15.6c.c.

m) Thickness of bran layer. (μ)

average.	max.	min.
40.90	46.58	33.75

p) Chemical composition :—

Water	13.70
Starch	73.98
Sugar	1.80
Crude protein	8.82
" fat	1.91
Ash	1.12

β) Polished rice, suitable for the Saké brewing. 23 (A-W) varieties.

A) *Production of Okayama prefecture.*

a) Percentage of full grown grains.—— 94.2

b) External appearance and luster. — White glassy luster, grains were fat and large. 1st class.

p) Chemical composition :—

Water	13.20	Starch	75.64
Sugar	0.46	Crude protein	9.04
Crude fat	0.37	Ash	0.35

B) *Production of Niigata prefecture.*

a) Percentage of full grown grains.—— 97.0

b) External appearance and luster. - Nearly same as A).

p) Chemical composition :—

Water	15.63	Starch	74.38
Sugar	0.61	Crude protein	7.32
Crude fat	0.54	Ash	0.37

C) *Production of Osaka prefecture.*

a) Percentage of full grown grains.——97.8
b) External appearance and luster.——Nearly same as A).
p) Chemical comosition :—

Water	13.20	Starch	78.16
Sugar	0.41	Crude protein	7.53
Crude fat	0.28	Ash	0.38

D) *Production of Hyogo prefecture.*

a) Percentage of full grown grains.——81.6
b) External appearance and luster.——Same as C).
p) Chemical composition :—

Water	12.80	Starch	76.63
Sugar	0.61	Crude protein	7.10
Crude fat	0.58	Ash	0.35

E) *Production of Hyogo prefecture.*

a) Percentage of full grown grains.——90.4
b) External appearance and luster.——Same as A).
p) Chemical composition :—

Water	12.00	Starch	77.23
Sugar	0.81	Crude protein	8.39
Crude fat	0.17	Ash	0.33

F) *Production of Hyoyo prefecture.*

a) Percentage of full grown grains.——96.6
b) External appearance and luster. —Same as A).
p) Chemical composition :—

Water	13.60	Starch	77.89
Sugar	0.46	Crude portein	7.32
Crude fat	0.52	Ash	0.24

G) *Production of Okayama prefecture.*

a) Percentage of full grown grains——88.8
b) External appearance and luster.——Same as A).
p) Chemical composition :—

Water	13.90	Starch	75.71
Sugar	0.38	Crude protein	8.18
Crude fat	0.38	Ash	0.31

H) *Production of Okayama prefecture.*

a) Percentage of full grown grains.——77.4
b) External appearance and luster.——Nearly same as G).
p) Chemical composition :—

Water	12.60	Starch	74.51
Sugar	0.46	Crude protein	7.10
Crude fat	0.44	Ash	0.41

I) *Production of Okayama prefecture.*

a) Percentage of full grown grains.——96.4
b) External appearance and luster.——Same as A).
p) Chemical composition :—

Water	12.50	Starch	75.74
Sugar	0.33	Crude protein	7.96
Crude fat	0.35	Ash	0.34

J) *Production of Hiroshima prefecture.*

a) Percentage of full grown grains.— 97.4
b) External appearance and luster.——Same as A).
p) Chemical composition :—

Water	12.30	Starch	75.46
Sugar	0.66	Crude protein	8.54
Crude fat	0.65	Ash	0.39

K) *Production of Okayama prefecture.*

a) Percentage of full grown grains.- —95.4
b) External appearance and luster. - —Nearly same as J).
p) Chemical composition :—

Water	12.40	Starch	76.00
Sugar	0.31	Crude protein	6.89
Crude fat	0 18	Ash	0.89

L) *Production of Okayama prefecture.*

a) Percentage of full grown grains.- 96.4
b) External appearance and luster.-- -Same as A).
p) Chemical composition :—

Water	12.00	Starch	74.65
Sugar	0.31	Crude protein	6.67
Crude fat	0.32	Ash	0.32

M) *Production of Okayama prefecture.*

a) Percentage of full grown grains. ——87.6
b) External appearance and luster.——Nearly same as L).
p) Chemical composition :—

Water	14.70	Starch	77.93
Sugar	0.41	Crude protein	7.75
Crude fat	0.14	Ash	0.31

N) *Production of Okayama prefecture.*

a) Percentage of full grown grains.——86.2
b) External appearance and luster.——Nearly same as A).
p) Chemical composition :—

Water	14.20	Starch	76.76
Sugar	0.46	Crude protein	7.96
Crude fat	0.59	Ash	0.38

O) *Production of Kumamoto prefecture.*

a) Percentage of full grown grains.——84.4
b) External appearance and luster.——Nearly same as A).
p) Chemical composition :—

Water	13.40	Starch	76.94
Sugar	0.26	Crude protein	8.64
Crude fat	0.23	Ash	0.95

P) *Production of Kumamoto prefecture.*

a) Percentage of full grown grains.——90.8
b) External appearance and luster.——Same as A).
p) Chemical composition :—

Water	12.60	Starch	78.18
Sugar	0.38	Crude protein	6.45
Crude fat	0.26	Ash	0.33

Q) *Production of Kumamoto prefecture.*

a) Percentage of full grown grains.——88.2
b) External appearance and luster.——Same as P).
p) Chemical composition :—

Water	12.40	Starch	76.88
Sugar	0.33	Crude protein	8.54
Crude fat	0.31	Ash	0.31

R) *Production of Kumamoto prefecture.*

a) Percentage of full grown grains.——89.6
b) External appearance and luster.——Same as Q).
p) Chemical composition :—

Water	12.30	Starch	75.79
Sugar	0 28	Crude protein	7.32
Crude fat	0.15	Ash	0.38

S) *Production of Akita prefecture.*

a) Percentage of full grown grains.——94.6
b) External appearance and luster.——Nearly same as A).
p) Chemical composition :—

Water	12.40	Starch	74.92
Sugar	0.76	Crude protein	8.18
Crude fat	0.11	Ash	0.31

T) *Production of Akita prefecture.*

a) Percentage of full grown grains.——97.1
b) External appearance and luster.——Same as S).
p) Chemical composition :—

Water	13.90	Starch	75 68
Sugar	0.41	Crude protein	7.75
Crude fat	0.29	Ash	0.29

U) *Production of Akita prefecture.*

a) Percentage of full grains ——99.4
b) External appearance and luster.——Same as T).
p) Chemical composition :—

Water	13.10	Starch	77 55
Sugar	0.46	Crude protein	7.32
Crude fat	0.33	Ash	0.31

V) *Production of Akita prefecture.*

a) Percentage of full grown grains.——94.8
b) External appearance and luster.——Same as U).
p) Chemical composition :—

Water	14.40	Starch	75.64
Sugar	0.46	Crude protein	7.32
Crude fat	0.36	Ash	0.26

W) *Production of Yamagata prefecture.*

a) Percentage of full grown grains.——98.0
b) External appearance and luster.——Nearly same as A).
p) Chemical compposition :—

Water	14.60	Starch	75.79
Sugar	0.41	Crude protein	7.75
Crude fat	0.50	Ash	0.46

TABLE XV. 1921 Husked rice.

(Suitable for the Saké brewing.)

	External appearance and luster.	% of full grown grains.	% of Shinairomai	Depth of longitudinal furrow. (μ)	Volume of 100 g. (c.c.)	Specific gravity	Weight of 1,000 grains. (g.)	Volume of 1,000 grains. (c.c.)	Hardness. (kilo)	Thickness of bran layer. (μ)	Water	Starch	Sugar	Crude protein	Crude fat	Ash
A	1st Class	91.4	13.0	44.3	124.5	1.42	25.8	18.4	5.73	41.4	13.64	74.37	1.99	8.39	1.56	1.22
B	〃	90.6	1.6	48.9	130.0	1.39	24.6	17.7	4.36	44.5	14.72	74.05	1.10	8.82	0.98	1.28
C	〃	89.4	17.6	56.0	125.0	1.40	25.2	17.9	5.15	41.5	14.40	75.48	0.76	8.54	1.75	1.17
D	〃	89.1	80.2	61.0	123.0	1.41	26.2	18.6	5.59	41.1	13.40	75.35	0.90	9.90	1.84	1.24
E	〃	95.1	79.8	56.0	121.0	1.41	25.5	18.1	5.29	41.8	12.80	73.19	1.35	7.53	2.07	1.28
F	〃	93.1	72.6	—	124.0	1.41	25.9	18.5	5.00	—	14.50	75.60	1.25	9.47	1.35	1.24
G	〃	92.9	79.9	51.9	124.5	1.40	27.2	19.4	5.13	42.0	14.40	75.65	1.26	8.82	2.14	1.10
H	〃	98.9	24.0	59.0	127.5	1.41	24.6	17.5	5.72	41.4	13.00	72.95	1.70	8.75	1.87	1.34
I	〃	92.7	72.8	51.7	123.0	1.40	25.9	18.4	6.16	43.5	12.60	75.35	0.90	9.04	2.43	1.27
J	〃	94.8	66.0	50.6	125.0	1.41	26.9	19.1	5.46	41.4	12.80	74.90	1.40	9.47	1.99	1.17
K	〃	90.5	14.8	53.4	126.0	1.40	26.5	18.8	5.55	41.0	13.80	74.14	1.00	9.90	1.68	1.14
L	〃	93.2	3.4	53.8	125.0	1.42	23.9	16.9	5.62	42.0	13.00	73.18	0.81	9.47	2.01	1.31
M	〃	97.5	83.0	54.5	122.0	1.41	25.7	18.4	5.47	41.3	14.40	73.79	0.76	9.90	1.90	1.22
N	〃	88.9	25.2	49.5	126.0	1.40	27.7	19.8	4.43	41.7	14.07	72.79	1.70	9.90	1.52	1.13
O	〃	91.4	1.4	58.4	129.0	1.39	24.1	17.2	5.13	43.0	15.20	75.31	0.95	9.47	1.74	1.22
P	〃	82.2	9.1	56.9	126.0	1.41	24.3	17.3	5.71	42.6	13.60	72.47	1.60	8.18	1.39	1.23
Q	〃	91.3	4.0	53.8	126.0	1.40	24.2	17.3	5.49	42.1	15.03	73.80	1.25	9.04	1.54	1.08
R	〃	91.4	6.6	51.5	123.0	1.40	23.8	16.9	5.73	43.4	13.30	73.13	1.50	8.54	1.84	1.18
S	〃	95.3	4.4	47.6	126 0	1.41	25.1	17.8	6.30	43.6	13.90	73.79	0.76	9.90	1.90	1.22
T	〃	97.4	7.6	53.6	125.5	1.40	24.7	17.5	4.61	43.2	14.41	74.95	1.35	7.75	1.64	1.09
U	〃	95.1	16.8	54.9	125.5	1.41	24.9	17.8	5.20	43.9	14.20	76.32	1.20	8.82	1.95	1.06
V	〃	95.1	4.0	48.9	126.5	1.39	24.6	17.5	4.73	42.6	14.94	75.48	0.76	9.90	1.01	0.84
W	〃	92.3	1.0	57.7	127.0	1.42	22.0	15.6	6.30	40.9	13.70	73.98	1.80	8.82	1.91	1.12

TABLE XVI. 1921 Polished rice.
(Suitable for the Saké brewing.)

	External appearance and luster	% of full grown grains.	Water	Starch	Sugar	Crude protein	Crude fat	Ash
A	1st Class	94.2	13.20	75.64	0.46	9.04	0.37	0.35
B	〃	97.0	15.63	74.38	0.61	7.32	0.54	0.37
C	〃	97.8	13.20	78.16	0.41	7.53	0.28	0.38
D	〃	81.6	12.80	76.63	0.61	7.10	0.58	0.35
E	〃	90.4	12.00	77.23	0.81	8.39	0.17	0.33
F	〃	96.6	13 60	77.89	0.46	7.32	0.52	0.24
G	〃	88.8	13 90	75.71	0.38	8.18	0 38	0.31
H	〃	77.4	12.60	74.51	0.46	7.10	0.44	0.41
I	〃	96.4	12.50	75.74	0.33	7 96	0.35	0.31
J	〃	97.4	12.30	75.46	0.66	8.51	0.65	0.39
K	〃	95.4	12.40	76.00	0 31	6.89	0.18	0.89
L	〃	96.1	12.00	74.65	0.31	6.67	0.32	0.32
M	〃	87.6	14.70	77.93	0.41	7.75	0.14	0 31
N	〃	86.2	14.20	76.76	0.46	7.96	0.50	0.38
O	〃	84.4	13.40	76.94	0 26	8.54	0.23	0.95
P	〃	90.8	12.60	78.18	0.38	6.45	0.26	0.33
Q	〃	88.2	12.40	76.88	0.33	8.54	0.31	0.31
R	〃	89.6	12.30	75.79	0.28	7.32	0.15	0.38
S	〃	94.6	12.40	74.92	0.76	8.18	0.11	0.31
T	〃	97.1	13.90	75.68	0.41	7.75	0·29	0.29
U	〃	99.4	13.10	77.55	0.46	7.32	0.33	0.31
V	〃	94.8	14.40	75.61	0 46	7.32	0.36	0.26
W	〃	98.0	14.60	75.79	0.41	7.75	0.50	0.46

Summary of the 1921 production.

The suitable materials showed fine luster and external appearance, and in the size of grains, percentage of both full grown grains and Shinziromai, both weight and volume of 1,000 grains, hardness and the contents of carbohydrates, and crude protein showed nearly equal or somewhat higher value compared with the suitable materials of the production of the preceding years. On the other hand, in the depth of longitudinal furrow, volume of 100g., thickness of bran layer, and the contents of crude fat and ash showed the production of this year a smaller value than those of the preceding years, while in the specific gravity and water a moderate number was observed.

TABLE XVII. 1922

Rice suitable for the Saké brewing (husked 3 (A–C), polished 4 (A′–D).

	% of full grown grains.	Length of grain (m.m.)	Width of grain (m m.)	% of Shinziro-mai	Volume of 100g. (c c.)	Specific gravity	Weight of 1,000 grains. (g.)	Volume of 1,000 grains. (c c.)	Water	Carbohydrates
A Hyogo prefecture production	86.3	5.30	3.04	47.4	122.0	1.328	24.7	18.6	14.55	73.58
B Kumamoto prefecture production	92 0	5 10	2.95	17.0	125.0	1.379	22.2	16.1	14.03	73.29
C Akita prefecture production	94.0	5 06	3 06	22.0	125 0	1.387	23.3	16.8	15.20	71.78
A′ (A polished)	87.3	5.14	2.94	47 0	116.0	1 435	22.4	15.6	14.00	76.95
B′ (B polished)	85.3	4.95	2.90	23.0	116.0	1.443	20.2	14.0	13.57	80.61
C′ (C polished)	82.4	4.95	2.88	23.0	118.0	1.443	21.5	14.9	14.99	78.13
D Okayama prefecture production polished.	92.8	5.16	2.93	55.0	114.0	1.390	23.0	16.5	13.20	79.09

Table XVIII.

Husked rice, suitable for the Saké brewing.

	% of full grown grains.	% of Shinziromai	Depth of longitudinal furrow. (μ)	Volume of 100 g. (c.c)	Specific gravity	Weight of 1,000 grains. (g.)	Volume of 1,000 grains. (c c.)	Hardness. (kilo)	Thickness of bran layer (μ)	Water	Starch	Sugar	Crude protein	Crude fat	Ash
1916 18 varieties	88.08	35.26	54.30	126.4	1.394	24.29	—	5.58	45.53	14.03	70.44	2.59	7.30	1.73	1.28
1917 20 〃	86.77	42.02	54 01	126.0	1.402	24.47	17.48	5.06	45.40	13.28	73.42	1.14	7.74	2.40	1.11
1918 21 〃	91.24	74.00	42.97	124.9	1.406	25.70	18.10	4.61	47.40	12.41	75.21	0 98	7.87	1 39	1.41
1919 19 〃	94.40	23.70	50.25	124 7	1.401	25.40	18.00	5.36	42.80	13 35	72.45	0.95	8.73	1.88	1.17
1921 23 〃	92.75	29.90	53.36	125.3	1 406	25.20	17.92	5.40	42.32	13.90	74 35	1.22	9.01	1.74	1.18
Average 101 〃	90.67	41.17	50.91	125.4	1.400	25.03	17.88	5.18	44.55	13.39	73.64	1.35	8.26	1.82	1.23

Table XIX.

Husked rice, unfit for the Saké brewing.

	% of full grown grains.	% of Shinziromai	Depth of longitudinal furrow. (μ)	Volume of 100g. (c.c)	Specific gravity.	Weight of 1,000 grains (g.)	Volume of 1,000 grains. (c.c)	Hardness. (kilo)	Thickness of bran layer.(μ)	Water	Starch	Sugar	Crude protein	Crude fat	Ash
1916 4 varieties	86.61	25.85	53.98	125.1	1.40	24.80	—	6.45	53.88	12.60	73.44	2.02	7.31	2.24	1.29
1918 10 〃	81.20	59.14	46.53	128.9	1.40	22.41	16.00	4.84	47.87	12.49	74.89	1.13	7.97	2.10	1.37
1919 10 〃	78.20	1.40	53.68	129.6	1.39	23.00	16.30	6.13	47.84	13.15	72.33	0.93	8.67	1.94	1.24
Average 24 〃	80.85	29.11	50.75	128.6	1.40	23.05	16.48	5 64	48.87	12.78	73.58	1.19	8.14	2.06	1.30

Table XX.

Polished rice, suitable for the Saké brewing.

	% of full grown grains.	% of Shinsiromai	Depth of longitudinal furrow. (μ)	Volume of 100g. (c.c.)	Specific gravity	Weight of 1,000 grains. (g.)	Volume of 1,000 grains. (c.c.)	Hardness. (kilo)	Water	Starch	Sugar	Crude protein	Crude fat	Ash
1916 6 varieties	90.59	44.48	38.82	120.7	1.438	23.50	—	4.35	13.42	78.40	1 05	6.37	0.35	0.53
1917 20 〃	87.25	49.68	37.56	118.3	1.441	22.61	15.55	3.62	13.34	78.36	0.39	6.88	0.26	0.40
1918 21 〃	91.13	67.78	29.86	119.1	1.439	23.18	16.30	3.99	12.23	79.50	0.71	6.63	0 47	0.45
1919 19 〃	—	—	32.71	—	—	—	—	4.40	14.70	74.99	1.09	8.37	0.26	0.59
1921 23 〃	92.61	—	—	—	—	—	—	—	13.22	79.35	0.45	7.69	0.35	0.39
member of variety.	70	47	66	47	47	47	41	66	89	89	89	89	89	89
Average.	90.55	57.10	33.37	119.4	1.440	22.93	15.93	3.92	13.23	77.39	0.67	7.31	0.32	0.45

Table XXI.

Polished rice, unsuitable for the Saké brewing.

	% of full grown grains.	% of Shinsiromai.	Depth of longitudinal furrow. (μ)	Volume of 100 g (c.c.)	Specific gravity.	Weight of 1,000 grains. (g.)	Volume of 1,000 grains. (c.c.)	Hardness. (kilo)	Water	Starch	Sugar	Crude protein	Crude fat	Ash
1916 6 varieties.	91.69	19.73	40.25	124.3	1.433	20.86	—	4.50	13.67	77.60	1.01	6.70	0.59	0.66
1918 12 〃	79.20	47.01	36.62 (10v.)	122.3	1.430	20.42	14.32	3.92	11.84	79.73	0.59	5.89	0.45	0.50
1919 10 〃	—	—	40.50	—	—	—	—	4.35	14.50	73.81	0.97	8.26	0.47	0.54
member of variety.	18	18	26	18	18	18	12	28	28	28	28	28	28	28
Average.	83.36	37.92	38.97	123.0	1.431	20.57	14.32	4.17	13.18	77.18	0,82	6.89	0.49	0.55

III Conclusions.

As the results of investigations on 242 varieties (husked 125, polished 117) of rice used in Saké brewing, the following conclusions are drawn.

1. Both luster and external appearance ought to be fine for the brewing rice just as for the food stuff. The colour should be light and the shape, large and fat. The impurities must be as little as possible.

2. Full grown grains :- The suitable materials contain over 90% of full grown grains, while the unsuitable about 80%.

3. Size of grains :- Conveniently calculated from the volume and weight of 1,000grains. The volume and weight of 1,000grains are 17.88c.c. and 25.03g, respectively in the suitable materials, whilst 16.48c.c. and 23.05g. in the unsuitable.

4. Percentage of Shinziromai :- This varies according to the year of the production, but in the materials of the production of the same year, the suitable materials are, in many case, rich in Shinziromai, namely, the suitable materials contain 41.17% of it while the unsuitable 29.11%.

5. Volume of 100g :- The suitable materials occupy always a smaller volume (125.4c.c.) than the unsuitable (128.6c c.).

6. Specific gravity :- The suitable materials show somewhat greater value in the specific gravity than the unsuitable, except those of 1916 production. But the difference is so small that no reliable conclusion can be drawn on it, viz. the specific gravity of the suitable materials is 1.400 that of the unsuitable 1.3950.

7. Hardness :- In hardness, suitable materials always give a lower value than the unsuitable. But an extermely soft matreial is not fitted for the brewing. It ought to be moderate. The suitable materials resist the pressure up to 5.175 kilograms while the unsuitable up to 5.649 kilograms.

8. Depth of longitudinal furrow :- This shows no material difference both in the suitable and unsuitable materials. The average depth of it is 50.91μ in the suitable materials and 50.75 in the unsuitable. Compared with their size, however, the suitable materials give a smaller value than the unsuitable.

9. Thickness of bran layer :- Suitable materials have always a thinner bran layer (44.55μ) than the unsuitable ones (48.86μ).

10. Water—Smaller contents of water would be desirable from chemical stand point, but, since too small contents of water make the grains too hard, so the moderate humidity is rather desirable. The suitable materials contain 13.39% of water and the unsuitable 12.78%.

11. Carbohydrats (Starch, Dextrin, sugar) :- Suitable materials always indicate somewhat higher value (83.178%) in the contents of carbohydrates

than the unsuitable (82.944%).

12. Crude protein :– Suitable materials indicate somewhat ligher contents of crude protein compared with the unsuitable materials. This is so not only in husked rice but in polished rice, too. But the contents fluctuate according to the year of the produce. The contents ought to be as little as possible, since the protein is a source of fusel oil. It may be profitable to obtain some definite standard for the protein contents and the mean value is 8.263 % for the suitable materials and 8.144% for the unsuitable.

13. Crude fats :– The suitable materials ought to contain the crude fats as little as possible. The mean value for the suitable materials is 1.822% and for the unsuitable 2.058%.

14. Ash :– This too ought to be little. The mean value for the suitable materials is 1.23% and for the unsuitable 1.30%.

15. Saccharifying quality and absorption of water ought to be moderate, while the contents of crude fibre are the better, the smaller. Saccharifying quality—Suitable material 32.56% and the unsuitable 39.08%.

Absorption of water :– The suitable materials 22.33%, and the unsuitable 22.88%.

Crude fibre.—The suitable materials 1.2786%, and the unsuitable 1.292%.

Phosphoric acid :– The suitable materials 0.4989% and the unsuitable 0.4735%.

Phytin :– Phosphorus estimated as P_2O_5;

The husked rice (suitable) 0.4323%.

The polished rice (suitable) 0.0374%.

Reference (polished rice).

1. Both luster and external appearance :– Just in the same manner as in the husked rice.

2. Full grown grains :– The suitable materials show above 90%, while the unsuitable about 83%.

3. Size of grains :– In the same manner as in the husked rice—The suitable materials 22.93g. 15.93c.c. the unsuitable 20.57g. 14.32c.c.

4. Percentage of shinziromai :– The suitable materials 57.10, while the unsuitable 37.92.

5. Volume of 100g The suitable materials indicate 119.4c.c. while the unsuitable 123.0c.c.

6. Specific gravity—The suitable materials 1.44, the unsuitable 1.431.

7. Hardess :– The suitable materials 3.915 kilo., while the unsuitable 4.170 kilo.

8. Depth of longitudinal furrow :– The suitable materials 33.37μ, the

unsuitable 38.97μ.

9. Water :- The suitable materials 13.23%, the unsuitable 13.18%.
10. Carbohydrates(Starch, Dextrin, Sugar)—The suitable materials 86.6662 %, the unsuitable 86.5707%.
11. Crude protein:- The suitable materials 7.3148%, the unsuitable 6.8874%
12. Crude fat :- The suitable materials 0.3152%, the unsuitable 0.4888%.
13. Ash :- The suitable materials 0.4508%, the unsuitable 0.5457%

IV. Literature.

1. O. Kellner, Tanaka, Kobayashi :- Report of Tokio Imperial Collage of Agriculture and Forestry. No. 5.
Distribution of nutritious matters among rice by polishing process. They determined general chemical components of polished and crushed rice and bran.
2 O. Kallner, M. Nagaoka :- Bulletin of the collage of Agricultnre No. 12. Analysis of rice grain. Nine varieties of husked rice were analysed physically and chemically, also constituents of ash were determined. They concluded that market price of rice has no relation to its chemical composition, but the rice of good quality is rich in nitrogen contents.
3. M. Sawamura :- Journal of the Scientific Agricultural Society. No. 51. Relation between quality and chemical constituents of rice. He obtained nearly the same result with the former. He added that rice of inferior quality is rich in fat and ash and polished rice of inferior quality gave much water extract.
4. L. Grandeaŭ, C. de Leeuw, Wagner, O. Kellner, Konig, W. Pillitz, Brimmer, Hanamann, A. Petermann, F. Strohmer, N. V. Lorenz, Soxhlet, Henkel, Flourens, Berger, Meissl, Balland, Wattson, E. H. Jenkins, Richardson, U. Kreusler, J. B. Boussingault, A. R. Ledaux, Becke, Cosack, W. Kisch, Stift, Branberg, Uchiyama, Yamada, Nagaoka, Tsujioka, Saito, Sasaki, Sawano, Yoshii, Makino :- Konig's Nahrungs und Genussmittel 1903. They conducted chemical analysis of rice for about ten years since 1871.
5. Report of Osaka Sanitary Experiment Station 1891. Korean, Siam and Annam rice analysed chemically.
6. Rosenheim, Kajiura :- J. of Physiol. 36 liv-lv. 1908. They investigated protein matters in rice and obtained albumin, globulin and glutenin, but could not find prolamin, soluble in dilute ethyl alcohol. They named glutenin as oryzenin. The investigation was preliminary one, but further report has not yet been made.

7. U. Suzuki, K. Yoshimura :- J. of the Collage of Agriculture Vol. I No. 1.
On protein matters in rice. Almost the same time with the preceding article, they investigated protein matters in polished rice and bran, and obtained albumin, globulin, glutenin and prolamin. Further they isolated mono and diamino acids from glutenin by hydrolysis.

8. U. Suzuki, S. Matsunaga :- J. of the Collage of Agriculture Vol. V. No. 1.
On the presence of nicotinic acid in rice bran. They proved the presence of nicotinic acid in rice bran, which was once misunderstood by Funk as vitamin.

9. I. Inagaki, U. Suzuki, K. Aso :- J. of the Scient. Agricul. Society. No. 47.
On "Harajiro" part of rice. "Harajiro" part contains less crude protein compared with the other part of rice. The ratio between them was 76.1 to 100, while other constituents did not show any special difference.

10. K. Goto :- J. of Scient. Agricul. Society. No. 61.
Investigation on the quality of rice. Unripen rice when compared to full grown one indicates the less hardness, smaller specific gravity, and the smaller contents of crude protein, crude fat and nitrogen free extract, while crude fibre and ash show greater value.

11. I. Inagaki :- J. of Scient. Agricul. Society. No. 91.
On the relation between market price and quality of rice. Qualities proportional to the market price are weight of full grown grains, weight of a certain volume, specific gravity aud hardness, while weight of unripe grains, bran, impurities other than rice grains and white part of rice are inversely proportional.

12. U. Suzuki :- J. of Scient. Agricult. Society. No. 94.
On distributions and conbined state of iron in the polished rice and bran. The polished rice contains 0.005% of iron while bran contains 0.1–0.13%. Iron does not exist as an inorganic state but in an organic one. Bran contains much quantity of phosphorus, potash, magnesium and calcium compared with the polished rice.

13. U. Suzuki, T. Shimamura :- J. of Scient. Agricult. Society. No. 102, No. 103.
About an available composition aberi acid in rice bran. They found, in alcoholic extract of rice bran, an unknown indispensable nutritious constituent for growth of animals, and named it tentatively aberi acid.

14. B. Suzuki, T. Tanaka – J. of Scient. Agricult. Society. No. 129.

Relation between the quality of rice and the constituents of bran. The bran of good rice is rich in nitrogen and fat, while poor in ash.

15. B. Suzuki, T. Tanaka :– J. of Scient. Agricult. Society. No. 129.
Constituents of rice bran. As the bran of good rice, surely, contains much quantity of fat, rice may be graded by the quantity of fat in the bran.

16. I. Inagaki :– J. of Scient. Agricult. Society. No. 137, No. 138.
On an appraisement of rice. The rice of good quality ought to be hard, thin husked and fat grain, and to have sharrow longitudinal furrow, high luster, the less moisture, less unripen grains etc.

17. M. Kondo :– J. of Scient. Agricult. Society. No. 153.
On a volume weight of husked rice.
(1) A volume weight of husked rice will increase when the surface of grain is smooth, when the shape of grain is short elliptic and round, when mixed with fine sand and the shape of grain is not uniform. (2) A volume weight of husked rice will decrease when the surface of grain is not smooth, when the shape of grain slender and flat, when mixed with broken and unripen grains. (3) The size and dryness of grains are indifferent to the volume weight.

18. M. Kondo, F. Oshiumi :– J. of Scient. Agricult. Society. No. 168.
The relation between the volume weight and the degree of dryness of unhulled rice and husked rice.
(1) The volume weight is generally incraeased gradually according to dryness when the unhulled rice is dried by the the sun light or in a desiccator, while it is decreased when suddenly dried with artificial heat. (2) The volume weight is regularly increased according to the absorbed quantity of water by unhulled rice, quite independent of the way of drying. (3) The volume weight is decreased in proportional to the water content of husked rice which previously dried and kept to absorbe water in a moist atmosphere. This phenomenon is due chiefly to the swelling of grain than the increase of the weight of grain by the absorption of water.

19. I. Onodera :– J. of Scient. Agricult. Society. No. 180.
On the relation between the quality of rice and the fat contents of bran.
(1) The fat contents in the bran of better rice, are greater when compared to that of inferior ones, when difference of quality is great. (2) The fat contents of a full grown rice are greater than that of imperfectly matured ones. (3) When the larger grains are compared with the comparatively smaller grains, which constitute the greater part of

the sample, the latter contain much quantity of fat.

20. M. Kondo :– J. of Scient. Agricult. Society. No. 185.
On the thickness of the bran layer of rice during the stage of ripening. (1) The thickness of the layer of bran differs according to the stage of ripening of rice. The thickness is the greatest in the milky ripening, then in yellow ripening becomes somewhat thinner, and afterwards no special change is observed. (2) The external layer (pericarp, testa) of bran is most thick in milky ripenig, afterwards it becomes thinner according to the advance of ripening. (3) The inner layer (perisperm, aleuron layer) of bran is most thin in milky ripening, afterwards it becomes thicker in accodance with the progress of ripening. (4) The bran layer is thicker in an inferior rice and thinner in a superior one.

21. S. Suzuki :– J. of Scient. Agricult. Society. No. 187.
The relation between the degree of polishing and the chemical composition of rice or barley. (1) Both protein and crude protein decrease their quantities regularly in accordance with the degree of polishing. (2) Crude fat, crude fibre, ash, phosphoric acid. lime and aryzanin decrease in a considerable degree during the first stage of polishing, but their degree of decreasing comparatively lessens according to the progress of polishing. (3) Nitrogen free extracts increase in accordance with the advance of polishing process.

22. M. Sawamura, R. Kurosawa :– J. of Scient. Agricult. Society. No. 195.
The relation between the saccharification and the viscosity of the starch paste and the shape of the starch granule. The starch, which shows a strong viscosity in the state of paste, is slow as to its saccharification, but there is no regular rule among them, except cereals.

23. I. Kawasaki :– J. of Scient. Agricult. Society. No. 198.
The experiment on the movement of water is rice grains (Preliminary report). The volume weight of a husked rice, when moistened and afterward dehydrated by chemicals, is inversely proportional to the content of water. Brine does not give any bad effect to the quality of rice.

24. S. Kato, J. Ishikawa :– J. of Scient. Agricult. Society. No. 199.
The relation between the degree of dryness of unhulled or raw rice and husked rice, and a volume weight of them. Both unhulled and husked rice increase their volume weights in parallel with the degree of dryness.

25. M. Sawamura, R. Kurosawa ;– J. of Scient. Agricult. Society. No. 200.
Digestibility of polished rice, husked rice, sweet potatoe, tangle (lami-

noria), and Cortinellus Shiitake. The husked rice is less digestible compared with the polished rice.

26. Y. Noguchi :– J. of Scient. Agricult. Society. No. 245.
On the enzymes of preserved rice. The undermentioned facts are recognised in the rice during one and half years after the harvest.
(1) The activity of diastase somewhat suddenly decrease in July of the year after the harvest. After that time no considerable change is perceived, since the activity of diastase remained during one and half years after the harvest. (2) The activity of lipase and peroxidase, too, decreases gradually in accordance with the period of preservation and somewhat suddenly lessens in August of the year after the harvest. (3) The activity of catalase, too, lessens gradually, but no sudden change occurs. (4) The activity of oxydase does not change. (5) Either on unhulled or on husked rice the activities of these five enzymes do not seem to be affected by the change in the degree o dryness and the mode of preservation.

27. S. Sugihara :– J. of Scient. Agricult. Society. No. 248, No. 249, No. 250.
Physical investigations of cereals and their principal constituedts.
(1) A volume weight of husked rice when dried by some drying agent increases inversely to its water contents until the water contents are diminished to about 5–6%. But under 5% of water contents, the volume weight decreases proportionally to the water contents of rice. The reason of this phenomenon, is due to the fact that husked rice has the greatest density when it contains 5–6% of water while it has less density when it contains water less than 5% because the surface of rice grain becomes considerably rough when so dried and grains can not adhere closely one another. (2) A volume weight of polished or husked rice, is inversely proportional to its water contents. (3) A volume weight of polished rice decreases inversely to the quantity of sand used in the polishing process. (4) Dilute ethyl alcohol is the best liquid to prevent air bubbles adhered on the surface of husked rice. (5) Among many kinds of starches, potatoe starch has the greatest hygroscopicity, next comes the starch of an arrow root and a sweet potatoe, while the starch of rice, wheat and maize has the least hygroscopicity.

28. K. Goto :– J. of Scient. Agricult. Society. No. 265,
On enzymes and chemical compositions of husked rice in several periods of ripening.
(1) A yellow, riped rice seemes to contain somewhat greater quantity of sugar compared with that of a full ripened and the quantity of

starch is greater, while ash, protein, and crude fibre are less in the former. The activity of the enzymes lies between the milky and the dead ripen ones. (2) Rice of a dead ripe has the greatest diastatic power and the least peroxidase power. (3) Rice of milky ripe has a greater quantity of ash, fat, protein and fibre, while the least quantity of starch. Activity of diastase is the weakest, while that of peroxidase is the strongest by this period.

29. K. Aso :- R. of Imp. Agricult. Exp. Station. No. 45 1st.
Experiments on the enzymes in husked rice. Enzymes exist in husked rice are as follows.
(1) Oxydase, peroxidase, catalase, diastase, dextrinase, maltase, invertin, raffinase, lipase, urease, phytase and a protein splitting enzyme in a neutral medium. (2) Peroxydase is vigorous in a newly cropped rice and gradually lessens in accordance with the lapse of time. (3) Chlorine and formalin gases injure the function of lipase, diastase, and peroxidase, while cyanogen gas injure the action of peroxidase only. Chlorpicrin has no any influence for all these enzymes described above.

30. M. Aoi :- R. of Imp. Agricul. Exp. Station. No. 45 1st.
Investigations on the origin of disease in red changed rice.
(1) A fungus causes this disease belongs to the genus of oospora. (2) Pigment produced by the fungus exists in cell membrance and it does not dissolve in water, alcohol and ether. When made alkaline, the colour becomes reddish purple, but it recovers its original colour when acidified. (3) The optimum temperature for the growth of the fungus lies 24–28°C, the maximum being 35°C and the mimimum 11°C. (4) No poisonous effect was observed when two adult men ate 200g. each, every day during a week.

31. H. Kitamura :- R. of Imp. Agricul. Exp. Station. No. 43.
Investigations on the fatty matters in rice bran.
(1) Fatty matters in rice bran principally exist as glycerin esters of unsaturated fatty acids as oleic and linoleic acid and of saturated fatty acid as palmitic, moreover there exist a small quantity of phytosterol. It may, therefore, be supposed that the casily decomposable matter in rice bran should be olein and linolein. (2) The constants about fatty matters of rice are as follows.

Acid number	31.21	Iod number	104.88
Saponification number	184.76	Hehner's number	95.65
Ester number	153.55	Reichert meissl number	0.55

32. K. Aso, T. Nakoshi :- J. of Scient. Agricul. Society. No. 272.
The investigation of the enzymes of husked rice (continued). Also the

judgment of rice whether new or old.

(1) On the peroxide enzyme of husked rice newly cropped or old. 2g. of husked rice, grinded, mixed with 20c.c. water and tested about 5c.c. filtrate. (a) Reaction of guaijacum tincture—few drops of 1% solution of the tincture, a few drops of hydrogen peroxide solution of 1.5%—indigo colouration. (b) Reaction of guaijacol—few drops of 1% solution of guaiacol, a few drops of hydrogen peroxide solution of 1.5%—reddish brown colouration. (c) Reaction of pyrogallol—few drops of 1% pyrogallic water solution, a few drops of 1.5% hydrogen perxide solution–yellow colouration. (d) Reaction of paraphenylene diamine—a few drops aqueous solution of 1% paraphenylene diamine hydrochloride, a few drops of aqueous solution of sodium acetate, a few drops of 1.5% hydrogen peroxide solution—purple colouration. In the above reactions, newly cropped rice takes colour very well, but rice elapsed few years after crop, is coloured faintly, while rice preserved for a long years shows no colouration.

(2) On the catalase of husked rice newly cropped or old. Newly cropped husked rice indicates a strong reaction for catalase, but the husked rice elapsed one year after the crop shows the reaction in a considerably less degree. (3) On the reducing enzymes of husked rice newly harvested or old. Newly harvested husked rice indicates the reaction of a reducing enzyme distinctly, while that elapsed one year after the crop, shows no reaction. (4) On an ureasplitting enzyme of husked rice newly cropped or old. Newly harvested husked rice indicates the presence of an ureasplitting enzyme distinctly, but that elapsed three years after the crop indicates no reaction. (5) Relation of heat to enzymes in husked rice. There occurs no change of diastatic power of raw or husked rice, below 70°C in 3 hours. (a) Diastatic power in husked rice undergoes no perceptible change, when heated during three hours under 70°C, while it is remarkably retarded by heating three hours above 100°C. (b) Urease in husked rice is somewhat retarded in its action by heating above 80°C during two hours, while considerably retarded by heating above 100°C during three hours. (c) Phytase in husked rice is retarded in its action by heating at 100°C during three hours, when heated above 100°C during three hours, the reaction is evidently lessened. (d) Peroxidase in husked rice is retarded in its action by heating above 80°C during three hours, above 100°C during three hours, the reaction is remarkably decreased.

(6) Relation between the enzymes and the water contents of husked rice during storage. Activity of peroxide enzyme undergoes no any

influence, if water contents of husked rice are below 13%, while above 14% gradually decreasses its activity, if above 18% is distinctly retarded. Catalase, lipase, urease, phytase and diastase, too, indicate the same behaviour. (7) Mode of judgment of rice husked or polished, whether newly harvested or old. A large quantity of aqueous solution of 1% guaiacol, mixed with 20 grains of rice either husken or polished, stirred and is added with a drop of hydrogen peroxide solution–a newly cropped rice both husked and polished indicates reddish brown colouration on the parts of embryo and bran, but rice cropped in the previous year takes colour slightly on the part of embryo only.

33. Y. Kozai, H. Ando, U. Suzuki, T. Shimamura :– R. of Imp. Agricul. Exp. Station (extra) July 1910.

An investigation on a disease like beriberi of birds. Also, value of polished rice as foodstuff. The investigation has been begun in 1904. Phosphorus in rice bran exist in the form of phytin. The majority of iron exists, combined with a digestible protein, which is named as "ferroglobulin" Lime and magnesia are comprised chiefly in phytin, while the greater part of potassium exists as an inorganic compound. When birds are fed with the ferroglobulin extracted from rice bran, with moderate quantities of phytin, lecithin, potassium salt, sodium chloride and calcium carbonate, a disease like beriberi can be avoided or cured. As polished rice is unfit as a sole foodstuff, it is important to compensate the defect by selection of proper side dishes or by other methods.

34. K. Kondo :– J. of Societ. of Agricul. and Forest. Sapporo. No. 59.

On the protein in polished rice. Experiments were made on the refractivity of an alkaline solutions of both ordinary and glutinous rice. The refractivity changes in proportional to the density of a protein provided temperature and density of alkality are constant. Furthermore elementary analysis of protein were made.

35. T. Tadokoro, Y. Nakamura :– J. of Societ. of Agricul. and Forest. Sapporo. No. 65, No. 68, No. 72.

On oryzenin in ordinary and glutinous rice. Oryzenin of polished, ordinary rice is poor in carboxyl group, while rich in amino–acids group, compared with that of glutinous. Change caused by ultraviolet ray, is greater in the glutinous compared with the ordinary rice. When iodoprotein is prepared the protein of glutinous rice combines with much iodine than the ordinary one. Oryzenin of ordinary rice contain much ash than that of glutinous one. Iso electric points differ according to oryzenins of the different sources. That of ordinary

one approaches to a cathode, while that of glutinous one approaches to an anode. About the quantity of amino-acids number, oryzenin of ordinary rice is rich in ammonia form, while that of glutinous one is rich in mono-amino acid form when they are compared each other. Oryzenin of ordinary rice is always rich in nitrogen contents than that of glutinous one, when examined as the products of acetylifacation.

36. T. Tadokoro, Y. Nakamura, S. Watanabe :- J. of Collage. of Agricul. Hokkaido, Imp. Univers. Vol. XIV No. 3. Difference of the physical and chemical properties between glutinous and ordinary rice oryzenin. (1) As the refractvity of an alkaline solution of ordinary rice is greater than that of glutinous one, the former is acknowledged to be denser in its optical construction compared with the latter. (2) As the quantity combined of hydrochloric acid with oryzenin, after Cohnheim's method, is greater in ordinary rice than that of glutinous one, the former has the greater quantity of amino acids group to combine with hydrochloric acid, than the latter. (3) Ash contents of oryzenin of ordinary rice is greater than that of glutinous one. Ordinary rice has much sulphur and less phosphorus compared with glutinous one. (4) When amino acids are estimated, ordinary rice oryzenin contains, much nitrogen belonging to ammonia, arginin and lysine, while glutinous one contains much nitrogen belonging to monoamino acids, histidin and cystin.

37. T. Tadokoro, T. Takahashi, Y. Nakamura, S. Watanabe :- J. of Societ. Agricul. and Forest. Sapporo, No. 68.

Difference of the physical and chemical properties of starch between glutinous and ordinary rice. (1) Inorganic constituents of ordinary rice starch are greater than glutinous one. (2) Absorptive power of iodine in iod-alcohol by starch grain, is always greater in ordinary rice than in glutinous one. (3) Absorptive power of iodine in iod-iod-potassium solution, too, is greater in odinary rice than in the latter. (4) Heat of combustion is higher in ordinary rice starch than in the latter.

38. T. Tadokoro, S. Sato :- J. of Collage of Agricul. Hokkaido, Imp. Univers. Vol. XIII. No. 1.

On the difference of colloidality between glutinous and ordinary rice starch. (1) The swelling power of starch suspensoid in iodine solution is smaller in ordinary rice than in glutinous one. The former has strong resistance for sulphuric acid. (2) The affinity of glutinous starch to iodine is smaller compared to that of ordinary one. (3) The

absorptive power of glutinous starch to iodine is smaller than that of ordinary one.

39. U. Suzuki, T. Shimamura, S. Ohdake :– J. of Tokio. Chem. Societ. Band 32, 34.

On oryzanin, a constituent of rice bran. The four substances such as carbohydrate, protein, fat and inorganic salts have been regarded generally for a long time, as four indispensable nutritious factors. Nevertheless, by the results of many animal experiments carried out by them, it has been proved that animals can not achieve the complete development by those factors only. They experienced that animals can thrive completely, if a small quantity of an alcoholic extract of rice bran is added to those four factors mentioned above. Dr. Suzuki named this indispensable principle as oryzanin. This experiment has brought an epoch making discovery in the theory of nutrition. Oryzanin has, according to an elementary analyses, the molecular formula $C_{18}H_{16}N_2O_9$, and indicates strong diazo and Millon's reactions, a purple red colouration by ferric chloride, a slight green colouration by phosphomolybdic acid, a deep indigo colouration by ammonia and decolourises a blue colouration of iod–starch.

40. K. Sugimoto :– R. of Instit. of Nutrition. Vol. I No. 2.

Relation between a degree of polishing of rice and a digestive absorption coefficient. (1) A digestive absorption coefficient of every constituent in rice is increased provided the polishing process being advanced. (2) When equal quantities of rice having several different degree of polishing, are boiled and eaten, an actual quantity of the constituents (except carbohydrates) absorbed, decreases as the polishing degree proceeds; while of the nitrogenous matter, it is nearly the same in the rice of 7% loss of polishing, the half polished and the husked. (3) The quantity of materials excreted is remarkably decreased as the polishing degree proceeds. In husked rice it is particularly abundant. Rate of excreted matter of the constituents to the actual absorbed quantity, shows the highest percentage in the hushed rice, and then gradually decreases as the polishing degree proceeds.

41. K. Sugimoto,. M. Higuchi, S. Momoeda, Y. Hota, S. Tanaka :– R. of Institut. of Nurtition. Vol. I, No. 2.

Relation between an art of cookery of rice and a digestive absorption coefficient. (1) A digestive absorption coefficient is increased when rice is eaten as a dumpling (rice is powdered mixed with water, rounded to a ball, boiled) than as boiled rice, no matter husked or boiled. Boiled polished rice is better than a husked rice dumpling

in an absorption coefficient of each constituent. (2) When polished rice is eaten as a gruel, the digestive absorption coefficient is decreased in total nitrogen, carbohydrates and fat than eaten as boiled rice, but the absorption coefficient of ash is better in the former. (3) Digestive absorption coefficient is decreased in total nitrogen and carbohydrates, and increased in fat and ash, when polished rice is caten as a porridge than as boiled rice. (4) When polished rice is eaten as Sushi (boiled rice mixed with fish, vegetables and vinegar), the digestive absorption coefficient is somewhat increased than as boiled rice. (5) When polished rice is eaten as Sekihan (rice and red bean are mixed and steamed) the digestive absorption coefficient is inferior compared with ordinary boiled rice. (6) Of steamed rice (polished glutinous rice 7pt. polished ordinary rice 3pt.) and boiled polished rice, the former is somewhat inferior in the absorption coefficient of the total nitrogen, fat and ash, while that of corbohydrates are almost equal. (7) Glutinous rice when eaten as Mochi (rice steamed, kneaded to a mass or to a cake) the digestive absorption coefficient of each constituent is increased than the steamed rice.

42. F. Ando, H. Terada, S. Masuda, Y. Hoshino, C. Kanomata, H. Satow :– R. of Brew, Exp. Instit. No. 3, 4, 9, 10, 11, 12.
They investigated physical and chemical properties on a few kinds of polished rice used for Saké brewing.

43. T. Takahashi, H. Satow :– R. of Brew. Exp. Instit. No. 38.
On the chemical composition of polished rice, with special reference to the nutritive value of its protein matters for Saké yeast and Aspergillus Oryzae. Besides general chemical constituents of polished rice used for Saké brewing, four kinds of protein such as albumin, globulin, prolamin, and oryzenin were isolated. These four proteins were submitted to elemental analyses. Three proteins other than prolamin were utilized by the fungi.

44. T. Takahashi, H. Satow ;– R. of Brew. Exp. Instit. No. 64.
About tyrosin content in polished rice in regard to the quality of rice as raw material of Saké brewing. Since tyrosin in polished rice may be taken as an origin of bitter taste (tyrosol) of Saké, they tried to determine the quality of rice used for Saké brewing by the contents of tyrosin. This report is a preliminary one.

45. T. Tadokoro, S. Watanabe :– J. of Societ. of Agricul. and Forest, Sapporo. No. 65.
On a polishing degree of rice used for saké brewing and its protein contents. As protein matter among many important constituents of

rice, passes gradually into bran constituents in accordance with the degree of polishing, so it may be indicated the degree of polishing by the quantity of protein.

46. T. Tadokoro, Y. Nakamura, S. Watanabe :- J. of Societ. of Agricul. and Forest. Sapporo, No. 70, No. 72.

On the special characters of protein and starch in the varieties of rice used for Saké brewing. (1) The peculiarities of oryzenin in the varieties of rice used for Saké brewing, are as follows.—Always scanty in quantity of ash, differ in amino acid numbers, viz. poor in ammonia, melanin and lysine forms, while rich in histidin and cystin forms, compared to ordinary rice used as a food stuff. (2) The viscosity of starch paste of rice used for Saké brewing, is higher than that of oreinary rice used as food stuff. The quantity of ash of the former is poorer than that of the latter. (3) The quatity of silver in the silver salt of oryzenin of rice used for Saké brewing, is always greater when compared with the other. (4) The quantity of ash of oryzenin of rice used for Saké brewing is always less than the other. (5) Oryzenin of rice used for Saké brewing is poor in nitrogen in mono-amino, arginin and lysin forms, while rich in histidin and cystin forms, compared with that of the ordinary variety.